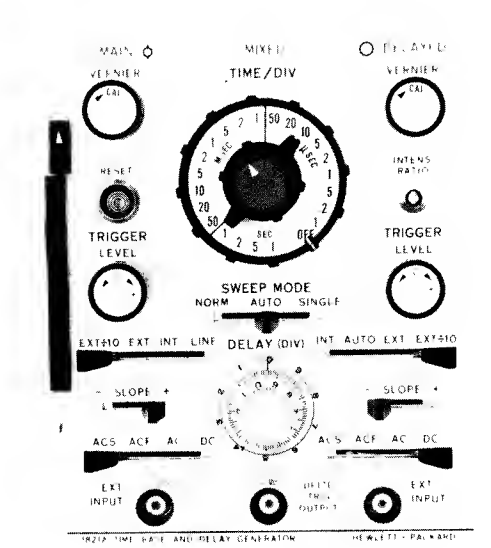
TIME BASE AND DELAY GENERATOR

1821A



HEWLETT hp PACKARD

HP 1821A

CERTIFICATION

The Hewlett-Packard Company certifies that this instrument was thoroughly tested and inspected and found to meet its published specifications when it was shipped from the factory. The Hewlett-Packard Company further certifies that its calibration measurements are traceable to the U.S. National Bureau of Standards to the extent allowed by the Bureau's calibration facility.

WARRANTY AND ASSISTANCE

All Hewlett-Packard products are warranted against defects in materials and workmanship. This warranty applies for one year from the date of delivery, or, in the case of certain major components listed in the operating manual, for the specified period. We will repair or replace products which prove to be defective during the warranty period provided they are returned to Hewlett-Packard. No other warranty is expressed or implied. We are not liable for consequential damages.

Service contracts or customer assistance agreements are available for Hewlett-Packard products that require maintenance and repair on-site.

For any assistance, contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.

MANUAL CHANGES

MODEL 1821A

TIME BASE AND DELAY GENERATOR

Manual Serials Prefixed: 809–
Manual Printed: JUNE 1968

Make all changes in this manual according to the Errata below. Also check the following table for your instrument serial prefix (3 digits) and/or serial number (8 digits) and make any listed change(s) in the manual:

Serial Prefix or Number	Make Manual Changes	Serial Prefix or Number	Make Manual Changes
809-03295 & higher	1		
821–	1		
905–	1, 2		
907–	1, 2, 3		

ERRATA

Table 6-2, Replaceable Parts,

A3: Change description to A: sweep time (incl A2 and A4).
Add A4: HP Part No. 01821-61905; TQ 1; A: sweep time switch.
C501: Change to HP Part No. 0160-3355; TQ 1; C: fxd poly 1 uF 5% 200 vdcw (preferred replacement).

Δ C504, C526: Change to HP Part No. 0160-3540; TQ 2; C: fxd poly 0.001 uF5% 100 vdcw (preferred replacement).

Δ C503, C525; Change to HP Part No. 0160-3541; TQ 2; C: fxd poly 0.01 uF 5% 100 vdcw (preferred replacement).

Δ C502, C524; Change to HP Part No. 0160-3542; TQ 2; C: fxd poly 0.01 uF 5% 100 vdcw (preferred replacement).

L102, L103, L107, L110. L201, L302, L305, L306: Change to HP Part No. 9140-0179; TQ 8; L: fxd 22 uh 10% (Preferred Replacement).
Q412: Change to HP Part No. 5080-0482; Q: Si fet (selected) (Preferred Replacement).
MISCELLANEOUS:
HP Part No. 01821-01204: Change to Bracket: plug (P2).
HP Part No. 01821-04101: Change to Plate: mounting (J1).

Page 8-5, Figure 8-4,
L102, L103, L107, L110: Change value to 22 uh.
Page 8-7, Figure 8-6,
L201: Change value to 22 uh.
Page 8-9, Figure 8-7,
L302, L305, L306: Change value to 22 uh.

CHANGE 1

Table 6-2, Replaceable Parts,
VR201, VR403: Change to HP Part No. 1902-0688; VR: breakdown, 53.6V.
Page 8-7, Figure 8-6, Schematic,
VR201: Change to 53.6V.
Page 8-11, Figure 8-8, Schematic,
VR403: Change to 53.6V.
Page 8-14, Figure 8-11,
J1: Move +15V power from pin 21 to pin 20.

CHANGE 2

Table 6-2, Replaceable Parts,
Add C108, C304: HP Part No. 0140-0149; TQ 2; C: fxd mica 470 pF 5% 300 vdcw.
Q101: Change to HP Part No. 1854-0215.
R113: Change TQ to 6.
R114, R305: Change to HP Part No. 0757-0442; TQ 6; R: fxd metflm 10 k ohms 1% 1/8W.
R140: Delete TQ.

11 December 1969

Δ = Latest additions to this change sheet.
This change sheet supersedes all prior change sheets for this manual.

Supplement A for
01821-90904

Instrument Serial Prefix	Make Manual Changes	Instrument Serial Prefix	Make Manual Changes
809-03295 & higher	1		
821-	1		
905-	1, 2		
907-	1, 2, 3		

CHANGE 2 (Cont'd)

Page 8-5, Figure 8-4, schematic,
Add C108, 470 pf, on S102 between ACS position and ground (next to R113).
R114: Change value to 10 k ohms.
Page 8-9, Figure 8-7, schematic.
Add C304, 470 pf, on S302 between ACS poistion and ground (next to R304).
R305: Change value to 10 k ohms.

CHANGE 3

Table 6-2, Replaceable Parts,
R103, R301: Change to hp Part No. 0698-6400; TQ2; R: fxd metflm 900 k ohms 1% 1/4 w.

OPERATING AND SERVICE MANUAL

MODEL 1821A
TIME BASE AND DELAY GENERATOR

SERIALS PREFIXED: 809

See Section VII For Instruments
With Other Prefixes

02591-4

PRINTED: JUNE 1968

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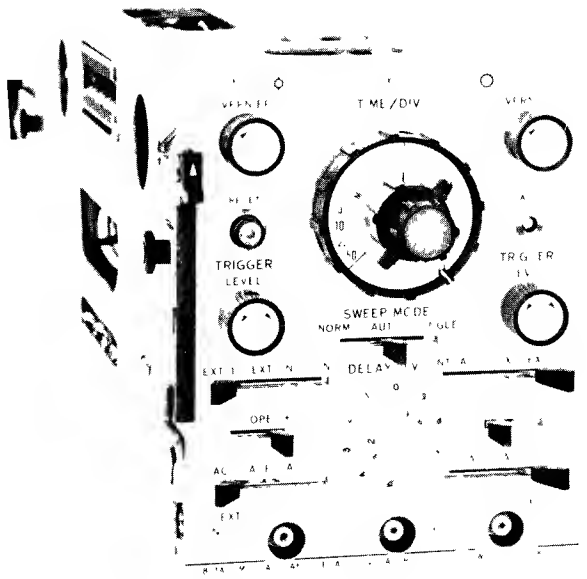


Figure 1-1. Model 1821A Time Base and Delay Generator

Table 1-1. Specifications

MAIN SWEEP:

RANGE:

0.1 μsec/div to 1 sec/div, 22 ranges in a 1, 2, 5 sequence; accuracy ±3%; vernier provides continuous adjustment between ranges and extends slowest range to at least 2.5 sec/div; Horizontal Magnifier, on Model 180-series Oscilloscopes, expands fastest range to 20 nsec/div (X5) or 10 nsec/div (X10) with 5% accuracy.

TRIGGERING:

NORMAL:

Triggering Coupling: DC, AC, ACF, ACS: AC attenuates signals below approximately 20 Hz; ACF attenuates signals below approximately 15 kHz; ACS attenuates signals above approximately 30 kHz.

Internal: see manual for Vertical Plug-In.

External: 0.5 v pk-pk from dc to 50 MHz (depending on Trigger Coupling) increasing to 1 v pk-pk at 90 MHz.

Line: power-line waveform is used for triggering.

Slope: selectable, positive or negative.

Trigger Point: adjustable ±3 v over selected trigger signal (±30 v in EXT ÷ 10).

AUTOMATIC:

Bright baseline displayed in absence of trigger signal. Triggering is same as normal except that lower frequency limit of trigger signal is 40 Hz.

DELAYED SWEEP:

RANGE:

0.1 μsec/div to 50 msec/div, 18 ranges in a 1, 2, 5 sequence: accuracy ±3%; vernier provides continuous adjustment between ranges and extends slowest range to at least 125 msec/div; Horizontal Magnifier, on Model 180-series Oscilloscopes, expands fastest range to 20 nsec/div (X5) or 10 nsec/div (X10) with 5% accuracy.

TRIGGERING:

AUTOMATIC:

Delayed sweep starts automatically at end of delay time. Slope, Trigger Point and Trigger Coupling are not selectable.

NORMAL:

Delayed sweep starts on first trigger signal after delay time.

Trigger Coupling: DC, AC, ACF, ACS: AC attenuates signals below approximately 20 Hz; ACF attenuates signals below approximately 15 kHz; ACS attenuates signals above approximately 30 kHz.

Internal: see manual for Vertical Plug-In.

SECTION I
GENERAL INFORMATION

1-1. INSTRUMENT DESCRIPTION.

1-2. The Hewlett-Packard Model 1821A Time Base And Delay Generator (shown in Figure 1-1) is a sweep generating plug-in unit for the hp Model 180-series Oscilloscope. Main sweep speeds are selectable in 22 ranges from 0.1 μsec/div to 1 sec/div. A vernier provides continuous adjustment between ranges and will extend the slowest sweep to at least 2.5 sec/div. The Magnifier switch on Model 180-series Oscilloscopes can expand the fastest sweep to 10 nsec/div. Delayed sweep speeds can be selected with 18 ranges from 0.1 μsec/div to 50 msec/div; the delayed vernier provides continuous adjustment between ranges and extends the slowest sweep speed to at least 125 msec/div. The main and delayed sweeps can be used either separately or combined to obtain a dual sweep-speed display.

1-3. The delayed sweep feature of the Model 1821A permits accurate time measurement between a reference signal and a point of interest on a complex waveform or pulse train; it also allows for exact time interval measurement between consecutive pulses in a pulse train or burst. The length of time before the delayed sweep starts is adjustable. The mixed sweep feature permits viewing simultaneously the character of an entire complex waveform and an expanded portion of the same waveform.

1-4. Single sweep operation is possible for any type of display. This feature may be used with any sweep speed to facilitate transient waveform photography. Normal triggering of the Model 1821A main sweep and delayed sweep may be selected to occur on an internal signal from the vertical plug-in or on an external signal up to 90 MHz (requires 0.5v pk-pk up to 50 MHz, increasing to 1v at 90 MHz). For the main sweep, automatic triggering provides a bright base line in the absence of an input signal; for the delayed sweep, automatic triggering starts this sweep at the end of the delayed period set. Trigger slope level, and coupling are controlled from the front panel for both the main and delayed sweeps. Table 1-1 provides complete specifications for the Model 1821A and Figure 1-2 illustrates typical displays obtainable with the plug-in.

1-5. SCOPE OF MANUAL.

1-6. This manual provides operating and service information for the hp Model 1821A Time Base And Delay Generator. This manual supplements the information presented in the Operating and Service Manual for the hp Model 180-series Oscilloscope. For specific information about any plug-in for the Model 180-series Oscilloscope, refer to the manual for that plug-in.

1-7. INSTRUMENT IDENTIFICATION.

1-8. Hewlett-Packard uses a two-section eight-digit serial number to identify instruments. The first three digits (preceding the dash) are the serial prefix which identifies a series of instruments; the last five digits identify a particular instrument in the series. The serial number appears on a plate located on the rear panel. All correspondence with a Hewlett-Packard Sales/Service Office in regard to an instrument should reference the complete serial number.

1-9. MANUAL CHANGES.

1-10. This manual provides complete information for any Model 1821A with a serial number prefixed (see Paragraph 1-7) by the three digits indicated on the title page. If the serial prefix of the instrument is different from that on the title page, a "Manual Changes" sheet supplied, or Section VII of this manual, will describe changes which will adapt this manual to provide correct coverage. Technical corrections (if any) to this manual, due to known errors in print, are called Errata and are shown on the change sheet. For information on manual coverage of any hp instrument, contact the nearest hp Sales/Service Office (addresses are listed at the rear of this manual).

Table 1-1. Specifications (Cont'd)

External: 0.5 v pk-pk from DC to 50 MHz (depending on Trigger Coupling) increasing to 1 v pk-pk at 90 MHz.

Slope: selectable, positive or negative.

Trigger Point: adjustable ±3 v over selected trigger signal (±30 v in EXT ÷ 10).

DELAY:

Time: continuously variable from 0.1 μsec to 10 sec; accuracy ±1%; linearity ±0.2%; time jitter is less than 0.005% of maximum delay of each range (1 part in 20,000).

Trigger Output (at end of delay time): approximately 1.5 v pulse with rise time less than 50 nsec from 1k ohm impedance.

MIXED SWEEP:

Dual sweep display in which main sweep drives first portion of display and delayed sweep completes display at speeds up to 1,000 times faster.

INTENSIFIED SWEEP:

The intensified section of the main sweep shows the time of the delayed sweep. It indicates the portion of the main sweep to be expanded full screen in delayed operation.

SINGLE SWEEP:

Front panel controls permit single sweep operation.

WEIGHT:

Net, 3-3/4 lbs (1,7 kg). Ship, 6-1/4 lbs (2,8 kg).

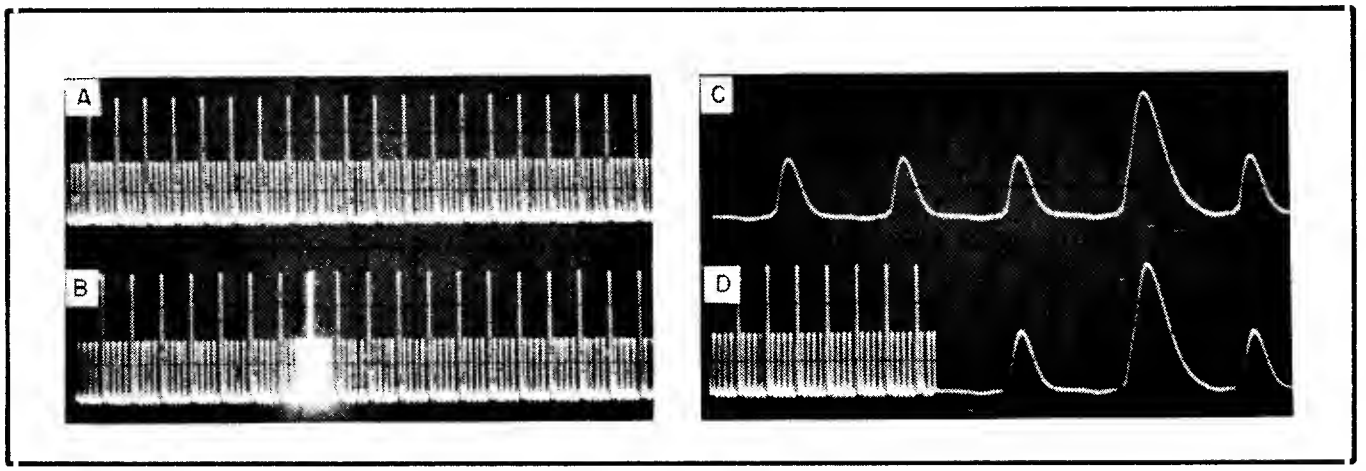


Figure 1-2. Waveforms illustrating sweep combinations using Model 1821A: (A) normal sweep; (B) intensified sweep (portion covered by delayed sweep is brightened); (C) delayed sweep (intensified portion of B is expanded to full 10 div); (D) mixed sweep (faster delayed sweep drives right portion of display).

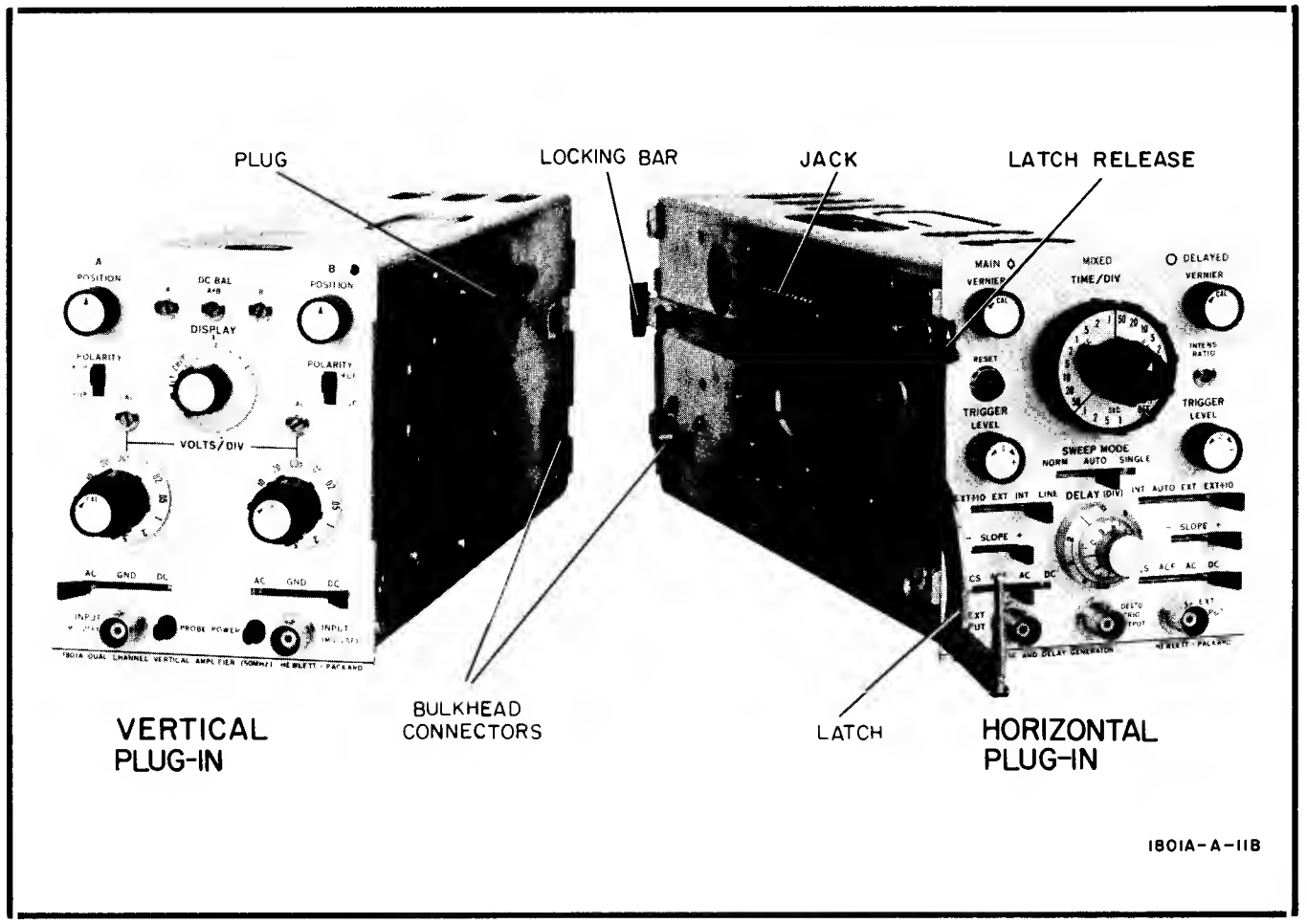


Figure 2-1. Plug-In Mating

SECTION II
INSTALLATION

2-1. INITIAL INSPECTION.

2-2. MECHANICAL CHECK. Check the shipping carton for damage immediately after receipt. If it is damaged, ask the carrier's agent to be present when the instrument is unpacked. Inspect the Model 1821A for physical damage such as bent or broken parts and dents or scratches. If damage is found, refer to Paragraph 2-4 for the recommended claim procedure. If the Model 1821A appears undamaged perform the electrical check (Paragraph 2-3). Retain the packaging material for possible future use.

2-3. ELECTRICAL CHECK. The performance check is given in Paragraphs 5-5 through 5-24. This check will determine whether or not the instrument is still operating within its specifications as listed in Table 1-1. The initial performance and accuracy of this instrument are certified as stated on the inside front cover of this manual. If the Model 1821A does not operate as specified, refer to Paragraph 2-4 for the recommended claim procedure.

2-4. CLAIMS.

2-5. If physical damage is found or if the instrument does not operate within specifications, notify the carrier and the nearest Hewlett-Packard Sales Service Office immediately. The Sales/Service Office will arrange for the repair or replacement of the instrument without waiting for a claim to be settled with the carrier.

2-6. The warranty statement for all Hewlett-Packard products is on the inside front cover of this manual. Contact the nearest Sales/Service Office for information about warranty claims.

2-7. REPACKAGING FOR SHIPMENT.

2-8. If the instrument is to be shipped to a Hewlett-Packard Sales/Service Office, attach a tag to it showing owner and owner's address, instrument's model number and 8 digit serial number, and a description of the services required.

2-9. The original shipping carton and packaging materials, except for the accordion-pleated pads, should be used for reshipment. If they are not available or reusable, the instrument should be repackaged with the following materials:

a. A double walled carton (refer to Table 2-1 for test strength required).

b. Heavy paper or sheets of cardboard to protect all instrument surfaces (use a nonabrasive material such as polyurethane or a cushioned paper such as Kimpak around all projecting parts).

c. At least 4 inches of tightly packed, industry approved, shock absorbing material, such as extra firm polyurethane foam.

d. Heavy duty shipping tape to secure outside of carton.

Table 2-1. Shipping Carton Test Strengths

Gross Weight (lbs)	Carton Test Strength (lbs)
up to 10	200
10 to 30	275
30 to 120	350
120 to 140	500
140 to 160	600

2-10. PREPARATION FOR USE.

2-11. The Model 1821A and the Vertical Plug-In are locked together and inserted as a unit, into the plug-in compartment of the Model 180-series Oscilloscope. This procedure is explained below. Power for the Model 1821A is supplied by the Oscilloscope.

2-12. Install plug-ins as follows:

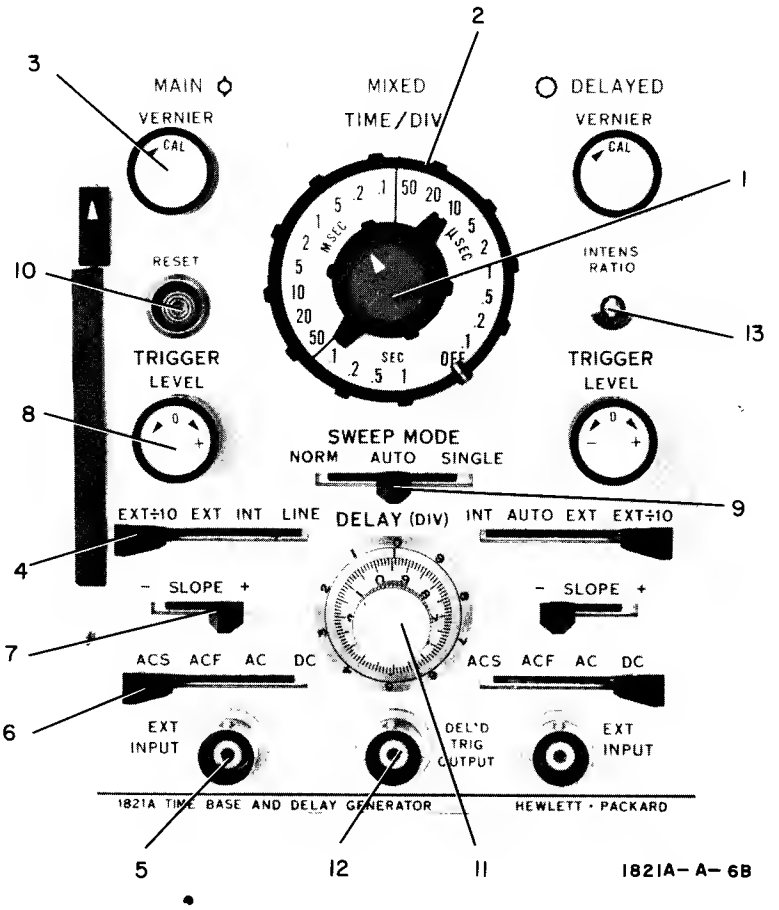
a. Move locking bar to rear (see Figure 2-1).

b. Fit vertical plug into horizontal jack (make certain that bulkhead connectors are aligned) and press plug-ins firmly together.

c. After ensuring that front and rear panels are aligned, push locking bar forward.

d. Lift the latch release and rotate latch downward. Insert plug-ins into the Model 180-series Oscilloscope.

e. Rotate latch upward and push forward to lock.



1. Sweep Display. Determines which sweep is displayed; main, delayed, or combination.
2. TIME/DIV (main). Selects the time represented by each horizontal centimeter when displaying the main sweep.
3. VERNIER (main). Adjusts time/div of main sweep between calibrated positions of the Main TIME/DIV switch.
4. Trigger Source (main). Selects source of Trigger Signal that starts main sweep.
5. EXT INPUT (main). Connector for applying an external trigger signal.
6. Trigger Coupling (main). Selects type of trigger signal coupling.
7. SLOPE (main). Determines which slope of trigger signal starts main sweep.
8. TRIGGER LEVEL (main). Selects point on trigger signal waveform that starts main sweep.
9. SWEEP MODE (main). Selects type of main sweep operation.
10. RESET (main). Arms circuit (lamp lights) so that next trigger will start a single sweep.
11. DELAY (DIV). Adjusts time between start of main sweep and arming of delayed sweep circuits.
12. DEL'D TRIG OUTPUT. Connector for applying positive trigger to external equipment. Trigger occurs when delayed sweep circuit is armed.
13. INTENS RATIO. Adjusts the intensity difference between the normal main sweep and its intensified section.

Figure 3-1. Controls and Connectors

SECTION III
OPERATION

3-1. INTRODUCTION.

3-2. The Model 1821A produces two linear sweeps for use as time bases in the Model 180-series Oscilloscope. The delayed sweep circuit is armed by the main sweep after an adjustable delay period. Control settings determine whether the delayed sweep is automatically triggered immediately after the delay, or if it is triggered by the next input signal. Waveforms may be viewed on either time base alone, or on both time bases combined.

3-3. CONTROLS AND CONNECTORS.

3-4. Locations of controls and connectors are shown in Figure 3-1 along with a brief description of their functions. Controls that perform the same function for both main and delayed sweeps are explained for main sweep only. The following paragraphs explain some control functions in more detail.

3-5. SWEEP DISPLAY. The three positions of this switch are MAIN, MIXED, and DELAYED. The display obtained in each position is explained below.

a. MAIN. The vertical input signal is displayed on a time base as set by the Main TIME/DIV control. With the Delayed TIME/DIV switch set to OFF the entire main sweep display will be of normal intensity. Any other setting of the Delayed TIME/DIV control will cause the main sweep to be intensified during the time the delayed sweep is produced (providing the delayed sweep is properly triggered).

b. MIXED. In this mode the first part of the presentation is displayed on a time base set by the Main TIME/DIV switch. The last part of the presentation is displayed on a time base set by the Delayed TIME/DIV switch. The delay between the start of the main sweep and the start of the delayed sweep is determined in part by DELAY (DIV).

c. DELAYED. The portion of the presentation that was intensified in MAIN is now displayed on a time base that is set by the Delayed TIME/DIV control.

3-6. TIME/DIV. The Main and Delayed TIME/DIV switches determine the time that it takes the main and delayed sweeps to move one division. The switches are concentric and interlocked so that the delayed sweep will always be faster than the main sweep. The Main TIME/DIV switch can select sweep speeds from 1 sec/div to 0.1 μsec/div. The Delayed TIME/DIV switch can select sweep speeds from 50 msec/div to 0.1 μsec/div. The selected main and delayed sweep speeds may be increased five or ten times by positioning MAGNIFIER on the Model 180-series Oscilloscope to X5 or X10 respectively. The Delayed TIME/DIV switch should be positioned to OFF to view a main sweep display of normal intensity.

3-7. VERNIER. The Main and Delayed VERNIER controls provide continuous adjustment of sweep time between the calibrated steps of their respective TIME/DIV switches. When the VERNIER control is set to CAL (fully cw) sweep time can be read directly from its TIME/DIV switch. As VERNIER is rotated ccw, the selected TIME/DIV increases. With VERNIER fully ccw, the TIME/DIV is approximately 2.5 times greater than the indicated TIME/DIV.

3-8. SWEEP MODE. This lever switch determines the type of main sweep triggering. The AUTO position allows the main sweep to free run, providing a bright baseline, in the absence of a trigger signal. A trigger signal will override the auto circuit if its frequency is 40 Hz or greater. NORM should be used if the trigger frequency is less than 40 Hz or if triggering is erratic. NORM, however, will not provide a baseline in the absence of a trigger. Selecting SINGLE allows the main sweep circuit to be triggered only once. The sweep circuit must be rearmed manually, by depressing RESET, to be triggered again.

3-9. DELAY (DIV). This control adjusts the delay between the start of the main sweep and the arming of the delayed sweep. The delay time is the product of the DELAY (DIV) setting and the Main TIME/DIV setting.

Note

A single DELAY (DIV) reading has little meaning. Accurate time measurements can be made only by subtracting one reading from another.

3-10. The delayed sweep starts exactly at the end of the delay time only if the Delayed Trigger Source switch is set to AUTO. All other positions of the Delayed Trigger Source switch cause the delayed sweep to start on the first trigger after the delay time.

Note

The delayed sweep will not be generated when DELAY (DIV) is set to less than approximately 0.5.

3-11. TRIGGER SOURCE. The Main and Delayed Trigger Source switches determine the origin of the main and delayed triggers. When INT is selected, the main and delayed sweeps are triggered by the vertical deflection signal. When EXT or EXT $\div$ 10 is selected the sweeps are triggered by the signals applied to the EXT INPUT connectors. EXT $\div$ 10 attenuates the external trigger and should be used when the trigger signal is greater than 6 v pk-pk.

3-12. Each switch has one position not common to the other. The LINE position on the Main switch allows the main sweep to be triggered by the power line waveform. The AUTO position on the Delayed switch causes the delayed sweep to start precisely at the end of the delay time set by DELAY (DIV). All other positions of the delayed switch cause the delayed sweep to start on the first trigger after the delay time.

3-13. TRIGGER COUPLING. These switches determine the type of coupling for the main and delayed

triggers. Direct (DC) coupling is normally used for any trigger signal from DC to greater than 90 MHz. Capacitive (AC) coupling should be selected when it is desirable to block the dc level of the trigger signal. AC coupling, however, will attenuate signals below 20 Hz. AC fast (ACF) attenuates signals below 15 kHz and is used, for instance, to eliminate 60 Hz ripple that might trigger the sweep. AC slow (ACS) attenuates signals above 30 kHz. ACS is used to eliminate high-frequency noise.

3-14. SLOPE. The setting of this switch determines whether the sweep triggers on the positive-going (+) or negative-going (-) portion of the trigger signal. When Delayed Trigger Source is set to AUTO the delayed SLOPE control does not function.

3-15. LEVEL. This control establishes the point on the trigger waveform that starts the sweep. This point is adjustable from -3 v to +3 v along the selected slope. With an external trigger and the Trigger Source switch in EXT÷10, the trigger point is adjustable from -30 v to +30 v along the selected slope. When the Delayed Trigger Source switch is in AUTO, the Delayed LEVEL control does not function. The Main LEVEL control can always vary the trigger point for the main sweep.

3-16. TRIGGER SIGNAL REQUIREMENTS.

3-17. Table 3-1 shows the trigger signal requirements of the Model 1821A with various combinations of control settings. Figure 3-2 is used in conjunction with the table to determine the typical trigger amplitude necessary at frequencies up to 100 MHz.

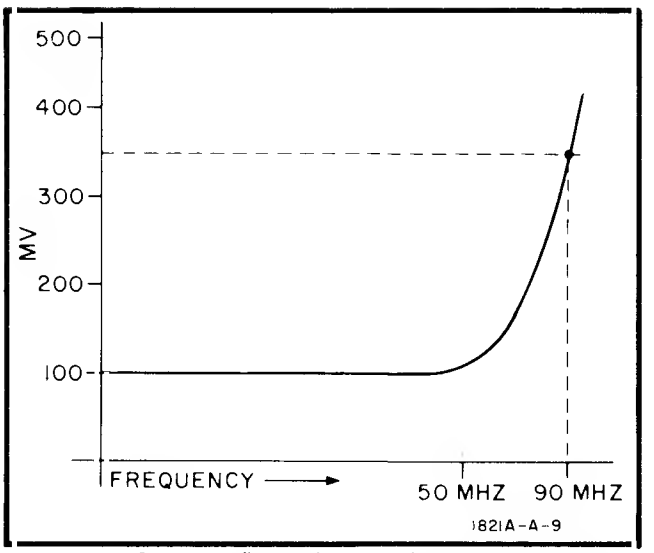


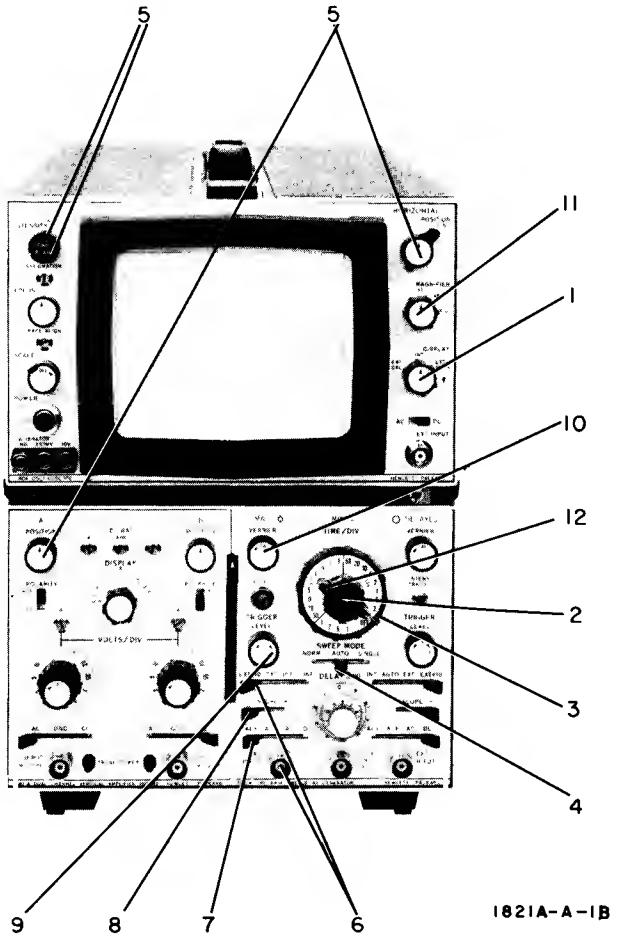
Figure 3-2. Trigger Amplitude Requirements

3-18. OPERATING INSTRUCTIONS.

3-19. Figures 3-3 through 3-7 give step-by-step operating instructions for the Model 1821A. These instructions are keyed to the photograph in each figure with index numbers. The preceding paragraphs contain additional information and should be read before using the operating instructions.

Table 3-1. Trigger Signal Requirements

	SWEEP MODE	TRIGGER SOURCE	TRIGGER COUPLING	TRIGGER AMPLITUDE	LEVEL	SLOPE
MAIN	NORM	LINE	DC: dc to 90 MHz AC: 20 Hz to 90 MHz ACF: 15 kHz to 90 MHz ACS: 20 Hz to 30 kHz	See Figure 3-2	Adjustable +3 v to -3 v	Selectable + or -
		INT				
		EXT				
		EXT÷10		10 times that shown on Figure 3-2	Adjustable +30 v to -30 v	
	AUTO	LINE	DC: 40 Hz to 90 MHz AC: 40 Hz to 90 MHz ACF: 15 kHz to 90 MHz ACS: 40 Hz to 30 kHz	See Figure 3-2	Adjustable +3 v to -3 v	
		INT				
		EXT				
		EXT÷10		10 times that shown on Figure 3-2	Adjustable +30 v to -30 v	
	SINGLE	Single may be selected after setting up any display				
DELAYED		AUTO	No function	Automatically triggered at end of delay	No function	
		INT	DC: DC to 90 MHz AC: 20 Hz to 90 MHz ACF: 15 kHz to 90 MHz ACS: 20 Hz to 30 kHz	See Figure 3-2	Adjustable +3 v to - 3 v	Selectable + or -
		EXT				
		EXT÷10		10 times that shown on Figure 3-2	Adjustable +30 v to -30 v	



Obtain a baseline as follows:

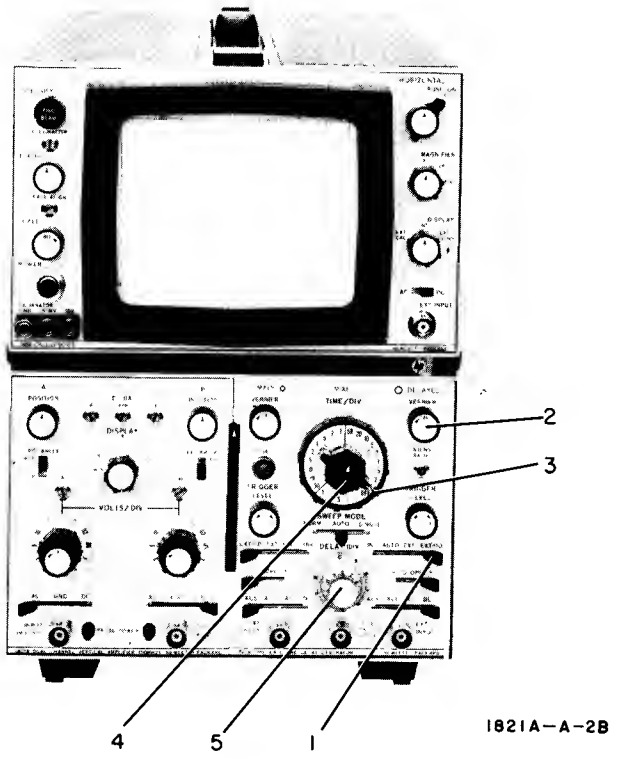
1. Set Horizontal DISPLAY to INT.
2. Set Sweep Display to MAIN.
3. Position Delayed TIME/DIV to OFF.
4. Set SWEEP MODE to AUTO.
5. Use FIND BEAM with INTENSITY and position controls, if necessary, to locate baseline.

Set controls of Vertical Plug-In as desired (refer to Vertical Plug-In Manual.)

Adjust Horizontal Display as follows:

6. Set Main Trigger Source as desired (if EXT or EXT ÷ 10 is selected connect trigger to Main EXT INPUT).
7. Select desired coupling.
8. Select desired slope.
9. Adjust TRIGGER LEVEL for desired trigger point. (If display is unstable, set SWEEP MODE to NORMAL and adjust LEVEL.)
10. Set Main VERNIER to CAL.
11. Set MAGNIFIER to X1.
12. Set Main TIME/DIV as desired.

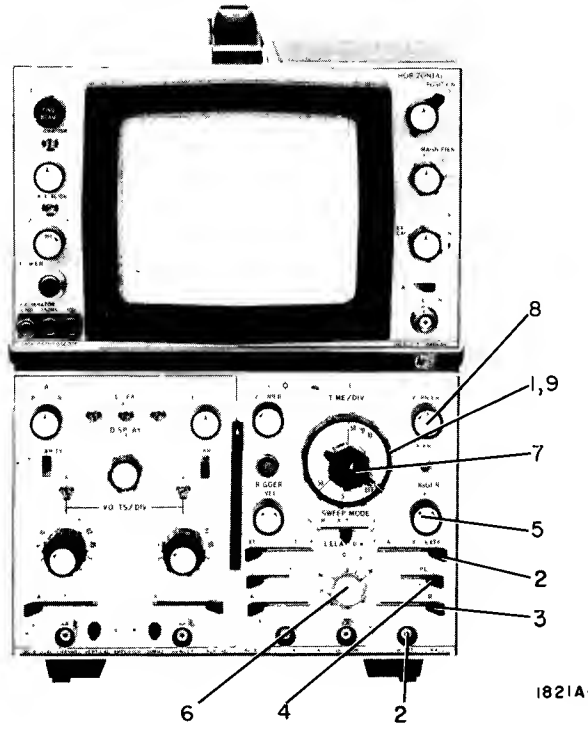
Figure 3-3. Main Sweep Operation



Set up main sweep as explained in Figure 3-3.

1. Set Delayed Trigger Source to AUTO.
2. Rotate Delayed VERNIER fully cw to CAL.
3. Rotate Delayed TIME/DIV switch ccw from OFF and set the delayed sweep time ten to one-hundred times faster than the main sweep time (if possible).
4. Set Sweep Display to MIXED.
5. Adjust DELAY (DIV) until desired portion of waveform is displayed on delayed sweep.

Figure 3-4. Mixed Sweep Operation



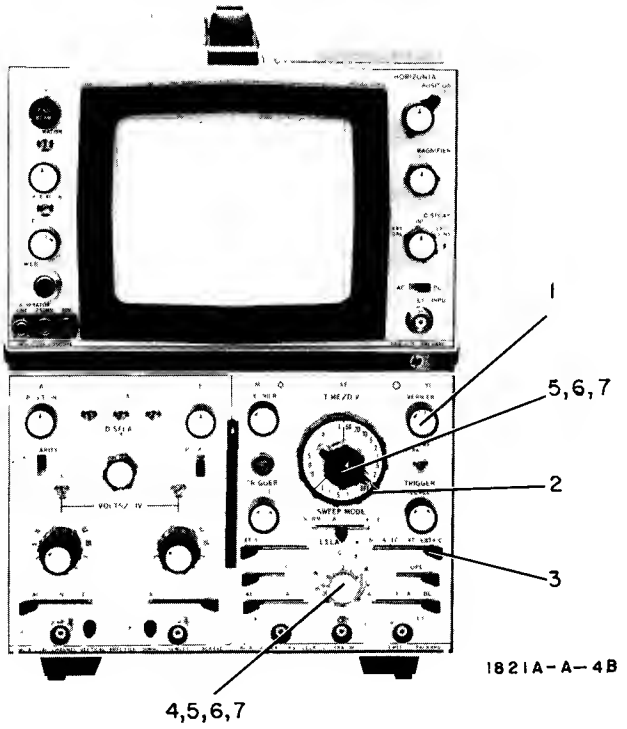
Set up main sweep as explained in Figure 3-3.

1. Rotate the Delayed TIME/DIV control ccw from OFF.
2. Set Delayed Trigger Source to INT, EXT, or EXT ÷ 10 as desired. (If EXT or EXT ÷ 10 is selected, connect trigger to EXT INPUT.)
3. Set Delayed Trigger Coupling as desired.
4. Set Delayed SLOPE as desired.
5. Adjust Delayed TRIGGER LEVEL for an intensified display. (If intensified display does not appear, set DIV DELAY to 1.)
6. Adjust DELAY (DIV) to intensify desired signal.
7. Set Sweep Display to DELAYED and observe previously intensified portion of signal.
8. Set Delayed VERNIER to CAL.
9. Set Delayed TIME/DIV as desired.

Note

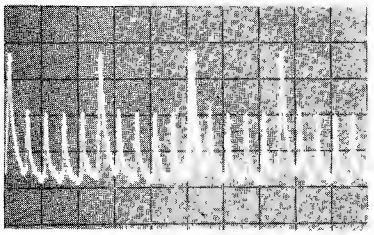
The dotted horizontal lines on the CRT are the 10% and 90% references.

Figure 3-5. Rise Time Measurements

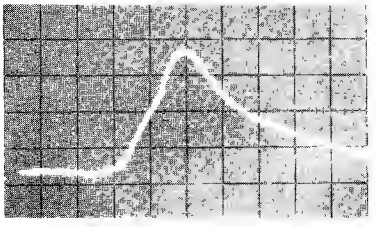


Set up main sweep as explained in Figure 3-2.

1. Set Delayed VERNIER to CAL.
2. Turn the Delayed sweep on by setting Delayed TIME/DIV ten to one-hundred times faster than Main TIME/DIV.
3. Set Delayed Trigger Source to AUTO.
4. Adjust DELAY (DIV) to intensify first point of interest, A, on waveform.

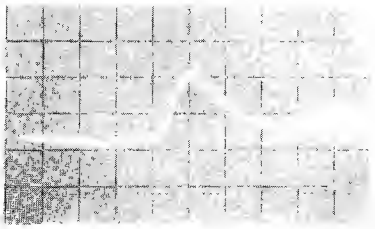


5. Set Sweep Display to DELAYED and adjust DELAY (DIV) to set A on a referency (Typically the Y axis). Note setting of DELAY (DIV).



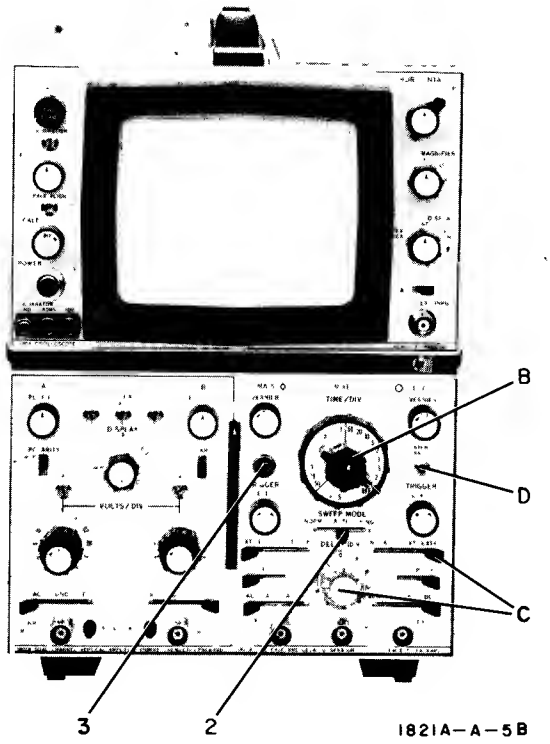
6. Set Sweep Display to MAIN and adjust DELAY (DIV) to intensify second point of interest B.

7. Set Sweep Display to DELAYED and adjust DELAY (DIV) to set B on same reference line as A.



Calculate the difference between the setting of DELAY (DIV) in steps #5 and #7. Multiply the MAIN TIME/DIV setting by this difference to obtain the time between the two points A and B.

Figure 3-6. Time Differential Measurements



SINGLE SWEEP

1. Perform instructions given in any previous operating procedure.
2. Set SWEEP MODE to SINGLE.
3. Press RESET to arm sweep.
4. The RESET indicator will light, indicating sweep is armed. The first trigger input will start the sweep. The RESET indicator will extinguish at the end of the sweep.

INTENSITY RATIO

A. Perform steps 1 through 5 of Figure 3-3.

B. Set Main TIME/DIV to 50 μSEC and Delayed TIME/DIV to 5 μSEC.

C. Set Delayed Trigger Source to AUTO and DELAY (DIV) to 2.00.

D. Adjust INTENS RATIO for desired intensity difference between normal and intensified section of baseline.

Figure 3-7. Single Sweep Operation And Intensity Ratio Adjustment

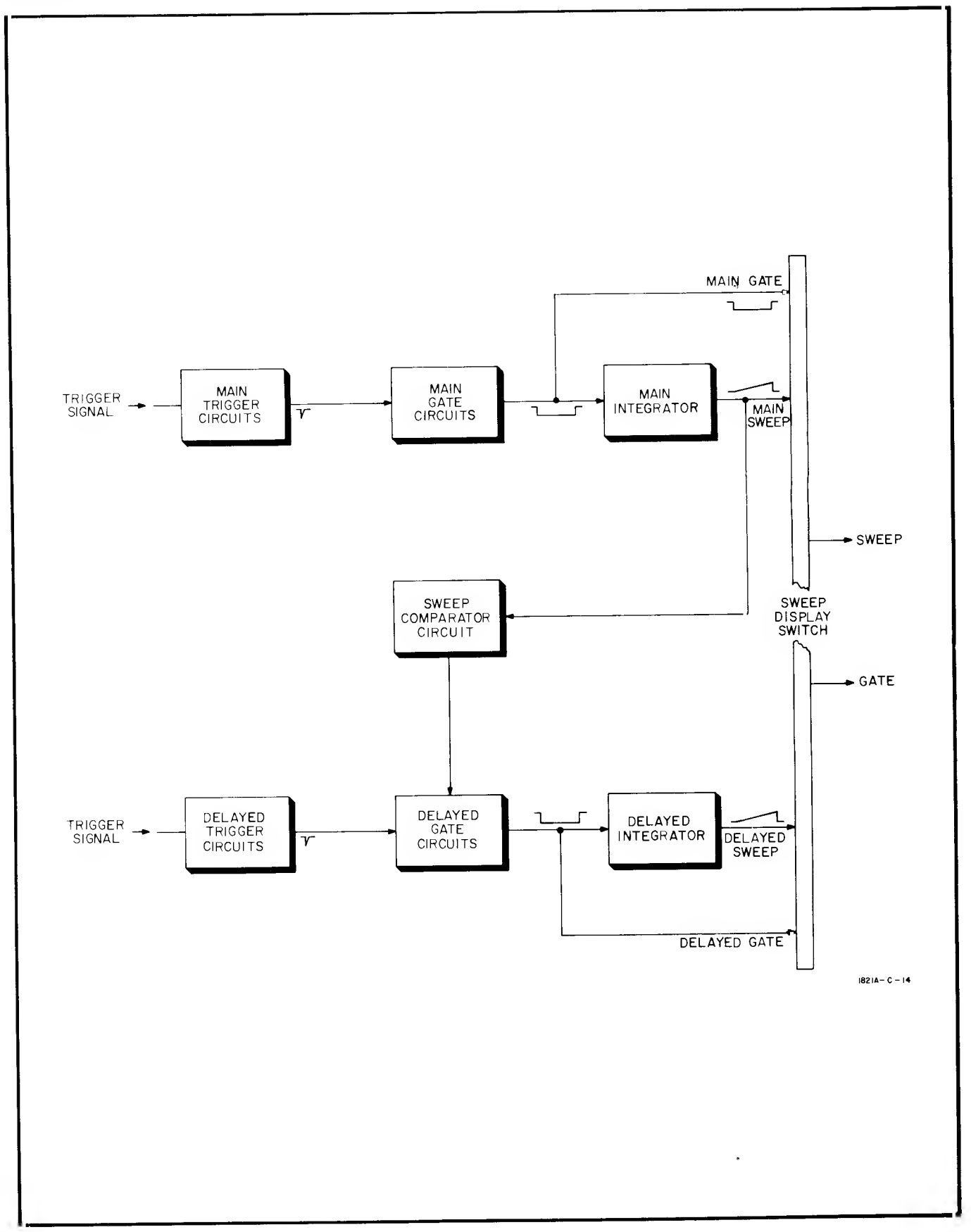


Figure 4-1. Model 1821A Block Diagram

SECTION IV
PRINCIPLES OF OPERATION

4-1. INTRODUCTION.

4-2. The Model 1821A Time Base and Delay Generator produces two linear sweeps for use as time bases in the Model 180-series Oscilloscopes. Either sweep, or a combination of both, may be selected by front panel controls. The selected sweep is applied to the Oscilloscope to drive the horizontal amplifier. Figure 4-1 is an over-all block diagram that shows the principal circuits of the Model 1821A and their relationship to each other.

4-3. The trigger generators each produce a fast-rise negative pulse at some point on the trigger signal. The gate generators are "fired" by these pulses and produce negative gates that are coupled to the integrators. Each integrator generates a positive sweep during the time it is unclamped by the gates.

4-4. The sweep comparator generates a positive pulse at some time after the start of the main sweep. This pulse "resets" the delayed gate generator to a pre-trigger condition. Since the delayed gate generator can not be fired until it is reset, the delayed gate and sweep always start after the main gate and sweep.

4-5. The main and delayed gates from the gate generators, and the main and delayed sweeps from the integrators are applied to the Sweep Display switch. This front panel control couples the main and delayed signals, in various combinations, to the Model 180-series Oscilloscope.

4-6. MAIN SWEEP.

4-7. The main sweep circuit is explained in the following paragraphs. The Block Diagram Description is a general explanation of circuit function while Circuit Details provides more complete information.

4-8. BLOCK DIAGRAM DESCRIPTION.

4-9. A block diagram of the main sweep circuit is shown in Figure 4-2.

4-10. NORMAL. Setting the SWEEP MODE switch to NORM disables the auto circuit and allows the main sweep circuit to operate normally. The selected trigger signal is applied to the trigger generator which produces a fast-rise negative pulse at some point on the trigger signal. The gate generator is "fired" by this pulse and produces a negative signal that is applied to the Sweep Display switch and to the integrator. When unclamped by this signal, the integrator begins to generate the main sweep. This linear positive-going sweep is applied to the Sweep Display switch and

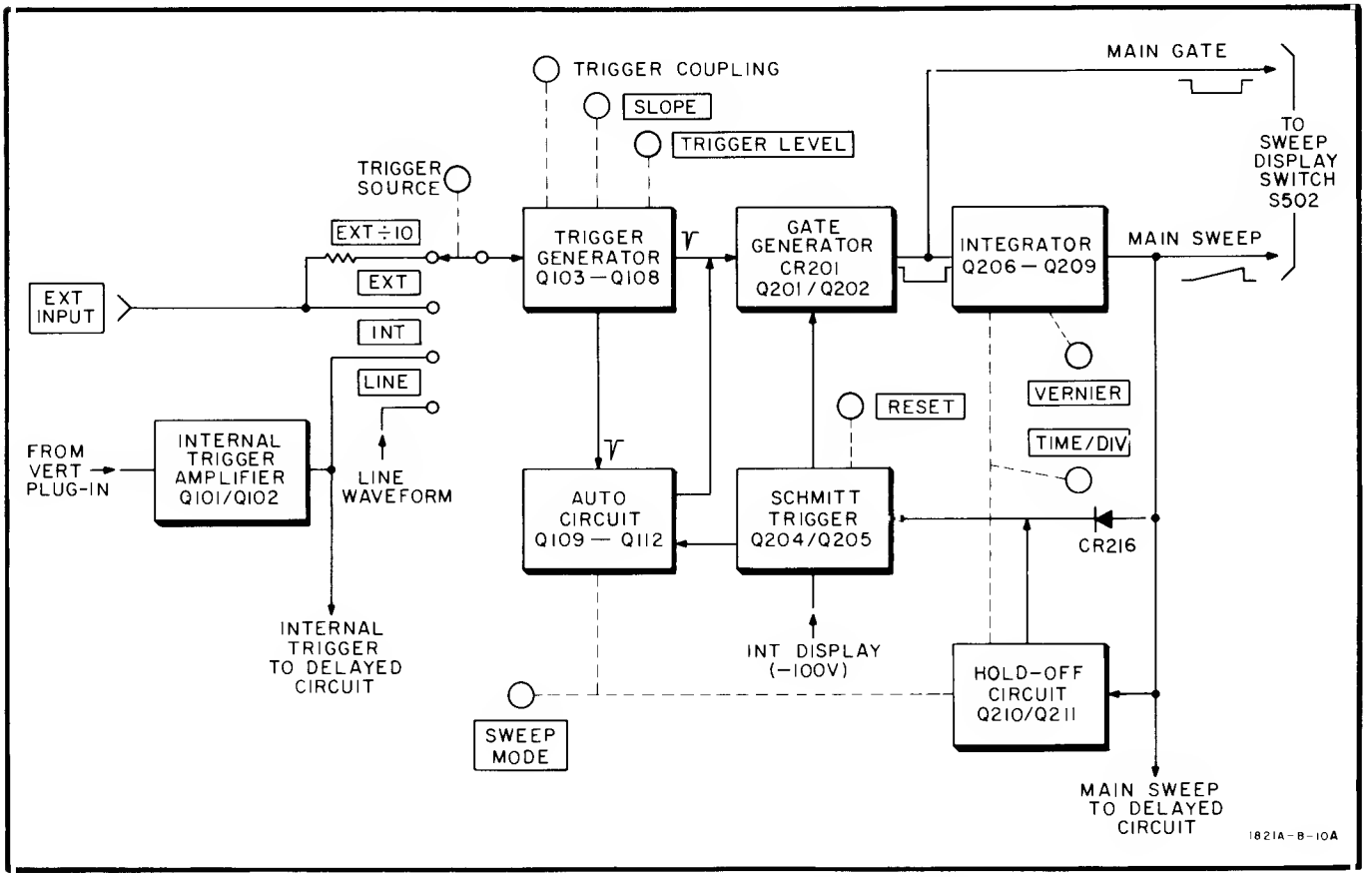


Figure 4-2. Main Sweep Circuit Block Diagram

to the Schmitt trigger. When the ramp (the positive-going portion of the sweep signal) reaches a predetermined amplitude, the Schmitt trigger changes state, causing the gate generator to turn off, terminating the main sweep. After a brief delay from the end of the sweep, the hold-off circuit generates a negative signal that switches the Schmitt trigger back to the pretrigger state. This action "resets" the gate generator. The next negative pulse from the trigger generator "fires" the gate generator again and the cycle repeats.

4-11. AUTO. Selecting AUTO with the SWEEP MODE switch activates the auto circuit. However, if a trigger signal greater than about 40 Hz is present, the signal from the trigger generator "locks out" the auto circuit. With the auto circuit "locked out", the main sweep circuit operates as it did in NORM. If the trigger signal drops below 40 Hz, or is removed, the auto circuit turns on. It is triggered by the Schmitt trigger at the same time the gate generator is "reset" and supplies the current necessary to "fire" the gate generator. This action causes the main sweep circuit to free-run -- its rate determined by the sweep speed.

4-12. SINGLE. Setting the SWEEP MODE switch to SINGLE disconnects the hold-off circuit from the Schmitt trigger. The gate generator must now be "reset" by depressing the RESET push button at the end of each sweep, manually switching the Schmitt trigger to the pretrigger state.

4-13. CIRCUIT DETAILS.

4-14. The following paragraphs provide more information about the main sweep circuit. Refer to the schematic diagram in Figures 7-4 and 7-6.

4-15. NORMAL. The trigger signal is obtained from one of three sources as determined by the Trigger Source Switch, S101. The external signal is obtained from a front-panel BNC connector; the line signal from the Model 180-series Oscilloscope; and the internal signal from the Vertical Plug-In through the internal trigger amplifier, Q101/Q102. Voltage divider R103/R104 attenuates the external signal by a factor of 10 when EXT÷10 is selected. Voltage divider R101/R102 attenuates the line signal to 10 v pk-pk. The selected trigger signal is coupled through the Trigger Coupling switch S102 to source follower Q103. Trigger Coupling switch S102 selects between direct coupling (DC) capacitive coupling (AC) a low-pass filter (ACS) and a high-pass filter (ACF). CR103 protects Q103 from excessive negative voltage. Q103 provides a high input impedance to the trigger signal and couples the signal to the trigger comparator, Q104/Q105.

4-16. The trigger comparator switches tunnel diode CR106 to a high-voltage state at a selected point on the trigger signal. Setting the SLOPE switch to + turns off CR104 and turns on CR105. Tunnel diode CR106 is connected through CR107 to the collector of Q104. The positive slope of the trigger signal, applied to the base of Q104, causes Q104 to eventually conduct hard enough to switch CR106 to a high-voltage state. The TRIGGER LEVEL control determines the base voltage of Q105 and therefore affects the bias on Q104. Adjusting the TRIGGER LEVEL control determines the voltage required to switch the tunnel diode. Diodes CR109 and CR110 protect Q104 and Q105 from reverse breakdown, base to emitter.

4-17. Setting the SLOPE switch to - turns off CR105 and turns on CR104. Tunnel diode CR106 is connected through CR108 to the collector of Q105. The trigger signal is coupled through Q104 to the emitter of Q105. Eventually the negative slope of the trigger signal turns on Q105 hard enough to switch CR106 to a high-voltage state. Since the TRIGGER LEVEL control determines the bias on Q105, it also determines the voltage required to switch the tunnel diode.

4-18. The negative-going rectangular wave produced by CR106 is differentiated by C118 and the emitter circuit of Q107. The resulting signal is coupled to Q108. Since Q108 is biased below cut-off, only the positive pulses are amplified and inverted. The fast-rise negative pulses from the collector of Q108 are coupled to the auto circuit "locking it out" and to the tunnel diode, CR201 (Figure 8-6). The current provided by the first negative pulse, combined with the current from Q204 is sufficient to switch CR201 to a high-voltage state. After the trigger pulse ends, the current from Q204 alone is sufficient to keep CR201 in this high-voltage state. The negative signal produced by CR201 is amplified and inverted by Q201 and Q202. Diodes CR202 through CR204 keep Q201 from saturating. The negative signal at the collector of Q202 is coupled to three places: (1) to P1 pin 14 and through the Model 180-series Oscilloscope to the rear panel, (2) to S502 as an intensity signal to unblank the CRT, and (3) to the Miller integrator circuit where it opens diode switch CR211/CR215.

4-19. When the diode switch opens, the timing capacitor (C501 through C510) begins charging through the timing resistor (R502 through R510) to the negative voltage on the wiper of R235. The TIME/DIV switch determines the slope of the negative-going ramp at the gate of Q207 in two ways: (1) by selecting various RC time constants; (2) by selecting the base voltage on Q206 which determines the charging voltage at R235. The VERNIER control, R235, adjusts the charging voltage between the calibrated steps of the TIME/DIV control. The positive-going linear ramp at the output of the Miller integrator is coupled to P1 pin 11 and through the Model 180-series Oscilloscope to a rear-panel connector, to R460 to arm the delayed sweep circuit, and to S502 for horizontal deflection.

4-20. The positive-going ramp is also picked off the wiper of R251 and applied to CR216. As the ramp goes positive, CR216 turns on and connects the ramp to the base of Q205. The ramp continues going positive until it reaches the upper hysteresis limit of the Schmitt trigger, when Q205 turns on, turning Q204 off. The current from Q204 through CR201 is removed, and the tunnel diode switches to a low-voltage state. The negative gate ends; the diode switch (CR211/CR215) closes and terminates the ramp. Disconnect diode CR216 opens when the ramp ends, disconnecting the sweep voltage from the Schmitt trigger. The base voltage of Q205 returns to a quiescent level and the Schmitt trigger remains in this new state. CR201 is now in a "no-trigger" condition and incoming negative trigger pulses have no effect.

4-21. As the main sweep was being generated, the positive-going ramp was also applied to the hold-off emitter followers, Q210 and Q211. The positive-going signal at the emitter of Q210 was coupled through CR218 and CR219 and discharged the selected hold-off capacitor (C514 through C520). When the ramp ended, CR218 turned off and the hold-off capacitor began to charge negatively. As the capacitor charges, CR217 turns on and connects the hold-off capacitor to the base of Q205. When the charge on the hold-off capacitor reaches the lower hysteresis limit of the Schmitt trigger, Q205 turns off, turning on Q204. Q204 now supplies current to CR201 "resetting" it to a pretrigger condition. The time between the end of one sweep and the turn-on of Q204 is called hold-off. A new sweep cannot be started until this time has elapsed. Hold-off is varied slightly as the Main TRIGGER LEVEL control is adjusted by varying the voltage at R254. This provides a stable display of certain discrete high frequency signals.

4-22. SINGLE. When SINGLE is selected with the SWEEP MODE switch, the output from the hold-off circuit is clamped to about 0 v by CR220. S201 must be depressed to provide the negative signal that turns off Q205, switching the Schmitt trigger to a pretrigger state and resetting CR201. At this time, Q203 is turned on, shorting R217 and lighting front-panel indicator DS201. RESET lamp DS201 therefore indicates that CR201 is "reset". The next trigger pulse will switch CR201 to a high-voltage state and the previous cycle will repeat.

4-23. AUTO. At the time Q205 is turned off, a positive pulse from the collector of Q205 is applied to the base of Q109 (Figure 8-4). If the SWEEP MODE switch is set to either NORM or SINGLE, the monostable multivibrator, Q110/Q111, is disabled, causing CR117 to open. Q112 is then biased into conduction, turning off Q109. The auto trigger from Q205 is blocked by Q109 and has no effect on the circuit.

4-24. If however, AUTO is selected (no trigger signal applied) Q110 turns on, turning off Q111. The negative voltage from the collector of Q111 turns off Q112. The relatively positive voltage from the collector of Q112 is blocked by CR114, and Q109 conducts when the auto trigger from Q205 is applied. The current from Q109 triggers CR201, and the main sweep circuit free-runs — CR201 being fired by the current from Q109 each time it is reset by the current from Q204.

4-25. When a trigger signal is applied, the negative pulses from the collector of Q108 are coupled to the base of Q111, switching the monostable multivibrator to its non-stable state (Q110 off — Q111 on). If the frequency of the trigger signal is above approximately 40 Hz, the multivibrator does not return to its stable state. The relatively positive voltage from the collector of Q111 is blocked by CR117 and Q112 is biased into conduction. The negative signal from the collector of Q112 turns off Q109, blocking the auto trigger. The next pulse from Q108 will fire the gate circuit and start a sweep. If the frequency of the trigger signal drops below 40 Hz, the sweep circuit will be alternately triggered and free-run, providing an unstable display.

4-26. DELAYED SWEEP.

4-27. A block diagram of the delayed sweep circuit is shown in Figure 4-3. The delayed sweep circuit is similar to the main sweep circuit. There are, however, three main differences: (1) the hold-off circuit is replaced by the sweep comparator; (2) there is no auto circuit; (3) triggering from the power-line waveform is replaced by automatic triggering.

4-28. BLOCK DIAGRAM DESCRIPTION.

4-29. The sweep comparator generates a positive pulse at a point on the main sweep, determined by the setting of the CM DELAY control. The pulse from the sweep comparator switches the delayed Schmitt trigger to a pretrigger state, resetting the gate generator. Setting the delayed Trigger Source switch to AUTO allows this same pulse to generate a trigger that fires the gate generator. In AUTO, the delayed sweep starts immediately at the end of the delay. Selecting either INT or EXT with the delayed Trigger Source switch, allows the selected trigger signal to produce the pulse that fires the gate generator. Using internal or external trigger signals cause the delayed sweep to start on the first trigger signal after the delay.

4-30. The negative output from the gate generator (when fired) is applied to the sweep display switch and to the integrator. The integrator, when unclamped by this signal, generates a positive-going ramp that is applied to the sweep display switch and to the Schmitt trigger. When the sweep reaches a preselected amplitude, the Schmitt trigger changes state, turning off the gate generator, terminating the sweep.

4-31. The sweep comparator will again generate a positive pulse at some time during the next main sweep and the previous cycle will repeat.

4-32. CIRCUIT DETAILS.

4-33. The following paragraphs contain more detailed information about the delayed sweep circuits. Refer to the schematic diagram in Figures 8-7 and 8-8.

4-34. The positive-going main sweep, applied to the base of Q411 (Figure 8-8) eventually causes the transistor to conduct hard enough to switch tunnel diode CR423 to a high-voltage state. Since the DELAY (DIV) control determines the gate voltage of Q412 it also determines the bias on Q411. As the DELAY (DIV) control is varied, Q411 switches the tunnel diode, CR423, to a high-voltage state at various times during each sweep. The negative signal generated by CR423 is inverted by Q410 and coupled to the base of Q403. The positive signal turns on Q403, switching the Schmitt trigger to a pretrigger state, resetting CR401. The positive signal from Q410 is also differentiated by C422 and R459 and coupled to the base of Q409. Since Q409 is normally cut-off, only the positive-going pulses are applied to the front-panel BNC connector, J401.

4-35. If AUTO is selected with the delayed Trigger Source switch (Figure 8-7) the positive pulse from Q410

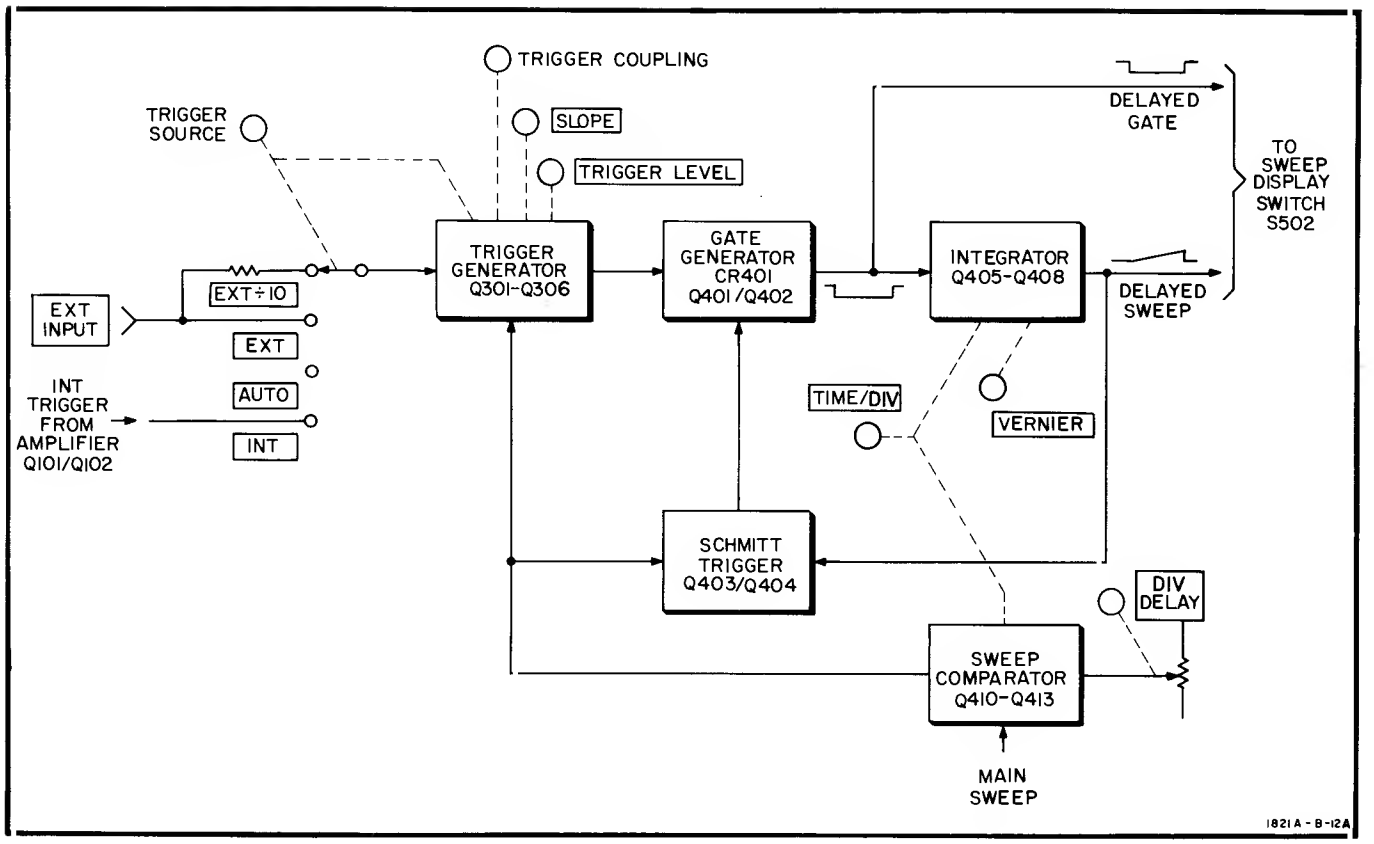


Figure 4-3. Delayed Sweep Circuit Block Diagram

is also coupled through CR309 to the base of Q306. The negative pulse from the collector of Q306 fires CR401 starting the delayed gate. In AUTO, therefore, the delayed gate and the delayed sweep start immediately after the delay.

4-36. Setting the delayed Trigger Source switch to either EXT, EXT÷10 or INT, reverse biases CR309. The auto trigger from Q410 is blocked and the gate circuit is not fired until the selected trigger signal produces a negative trigger pulse. In EXT, EXT÷10 or INT the delayed gate and sweep start on the first trigger signal after the delay.

4-37. The delayed trigger generator, gate generator, and integrator operate similarly to the main sweep circuits which are explained in Paragraph 4-13 to 4-20.

4-38. When the main sweep ends (Figure 8-8), Q411 turns off, switching CR423 to a low-voltage state. The negative output from the collector of Q410 turns off Q403, switching the Schmitt trigger to its pretrigger state. The current to CR401 is removed, the gate ends, and the delayed sweep is terminated. This action insures that the delayed sweep ends with the main sweep, preventing the main sweep from being triggered again while the delayed sweep is being generated.

4-39. SWEEP DISPLAYS.

4-40. The main and delayed gates and the main and delayed sweeps are applied to the Sweep Display switch. As the switch is rotated between the MAIN, MIXED, and DELAYED positions, various combinations of the applied signals are coupled to the Model 180-series Oscilloscope. A schematic diagram of the Sweep Display switch, S502, is given in Figure 8-10.

4-41. Figure 4-4 shows the displays obtained in the three positions of the Sweep Display switch. For illustration purposes, the vertical input signal is shown to be a repetitive series of six pulses. The first pulse has some minimum amplitude and each successive pulse is larger. The main gate and sweep start on the first pulse. The delayed gate and sweep are 2.5 times faster than the main, and start (at end of delay) just before the second pulse.

4-42. MAIN. Setting the Sweep Display switch to MAIN, couples the main sweep to the Oscilloscope for deflection. The main and delayed gates are combined and coupled to the Oscilloscope for intensity. The portion of the display that occurs during the delayed gate time is intensified. Diode CR502 limits the maximum amplitude of the delayed gate to a voltage selected by R525.

4-43. MIXED. Selecting MIXED, combines the main and delayed sweeps and applies them to the Oscilloscope. CR501 prevents the main sweep from feeding back into the delayed circuit. The delayed sweep however, couples through when it exceeds the amplitude of the main sweep. The main gate is coupled to the Oscilloscope for intensity. The first part of the display is on main sweep time and the last part on delayed sweep time. The display is an even intensity except for the difference caused by the different speeds of the main and delayed sweeps. When the delayed sweep

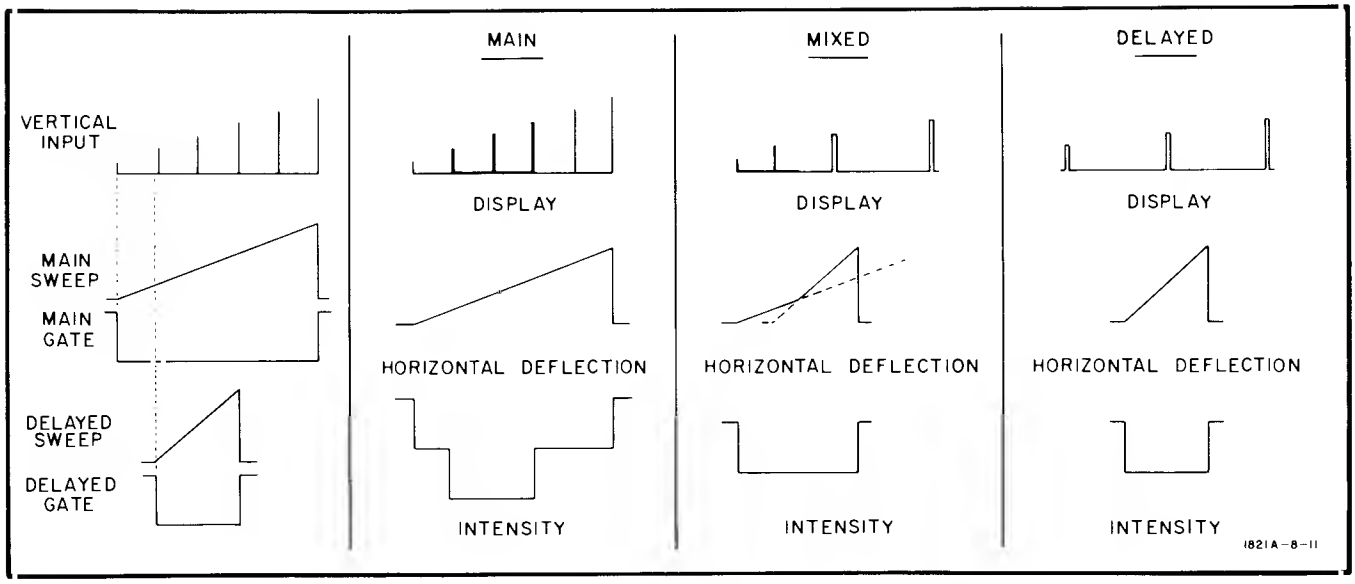


Figure 4-4. Sweep Displays

reaches maximum amplitude before the main sweep, the delayed sweep signal, feeding back into the main sweep circuitry, terminates the main sweep. This action insures that both sweeps terminate at the same time.

4-44. DELAYED. Selecting DELAYED, couples the delayed gate and sweep to the Oscilloscope. The portion of the vertical input signal that was intensified in MAIN, is now displayed at the delayed sweep speed.

Table 5-1. Required Test Equipment

Recommended Instrument		Required Characteristics	Par Ref.	Required for
Type	Model			
Signal Generator	hp Model 608 C/E or hp Model 3200 B	50 MHz & 90 MHz @ 1 v pk-pk	5-12	Triggering Check
Oscillator	hp Model 200 CD	40 Hz & 100 kHz @ 6 v pk-pk	5-13 5-31 5-32 5-33	Trigger Point & Slope Check Trigger Symmetry Check Main Sweep Length Adj Delayed Sweep Length Adj
Time Mark Generator	Tektronix Type 184	0.1 μsec to 1 sec @ 3 v pk-pk	5-14 5-15 5-16 5-17 5-18 5-19 5-20 5-21 5-22 5-23 5-34 5-35 5-36	Main Sweep Time Check Main Sweep Vernier Check Magnified Sweep Check Delayed Sweep Time Check Delayed Sweep Vernier Check Delay Time Accuracy Check Delay Time Linearity Check Jitter Check Delayed Trigger Output Check Mixed Sweep Check Main Sweep Time Adj Delayed Sweep Time Adj Sweep Comparator Adj
Oscilloscope	hp Model 140A w/1402A and 1423A	Sensitivity 0.1 v/cm sweep speed 50 nsec/cm	5-22	Delayed Trigger Output Check
10:1 Divider Probe	hp Model 10001A or hp Model 10004A	3% accuracy	5-22	Delayed Trigger Output Check
RF Voltmeter	hp Model 411A	0.5 v pk-pk @50 MHz 1 v pk-pk @90 MHz	5-12	Triggering Check
DC Voltmeter	hp Model 412A	1 v range 3% accuracy	5-30	Output Level Adj

SECTION V
PERFORMANCE CHECK AND ADJUSTMENTS

5-1. INTRODUCTION.

5-2. This section provides the performance check (Paragraph 5-5) and the adjustment procedures (Paragraph 5-24) for the Model 1821A. Trouble-shooting information, schematic diagrams, and component identification are in Section VIII.

5-3. TEST EQUIPMENT.

5-4. Test equipment required for maintaining and checking the performance of the Model 1821A is listed in Table 5-1. Test equipment with similar characteristics may be substituted if necessary.

5-5. PERFORMANCE CHECK.

5-6. The performance check verifies whether or not the Model 1821A is operating within the specifications as stated in Table 1-1. This check may be used as part of an incoming quality control inspection, as a periodic operational check, or after repairs and/or adjustments have been made. Recently calibrated test equipment should be used when performing this check.

5-7. A Performance Check Record is included in this manual on Page 5-7 and 5-8. As the initial performance check is accomplished, the actual reading should be entered on the form. The form should then be removed from the manual and filed in a safe place so that readings taken at a later date can be compared with the original readings.

5-8. The performance check must be performed in the sequence given. Do not attempt to start the procedure in mid-sequence as succeeding steps are dependent on control settings and results of previous steps.

5-9. PRELIMINARY SET-UP.

5-10. Lock plug-ins together and install in Model 180-series Oscilloscope. Apply power and allow a 15 minute warm-up. Make certain the Model 180-series Oscilloscope is calibrated. Perform Intensity Ratio Adjustment, Figure 3-7, before attempting performance check.

5-11. INITIAL CONTROL SETTING.

a. Model 180-series Oscilloscope:

MAGNIFIER	X10
Horizontal DISPLAY	INT

b. Vertical Plug-In (set controls as applicable):

Vertical Display	A
Channel A Polarity	+UP
Channel A Vernier	CAL
Channel A Volts/cm	0.1
Channel A Coupling	AC

c. Model 1821A Time Base:

Sweep Display	MAIN
SWEEP MODE	AUTO
DELAY (DIV)	1.00
Main VERNIER	CAL
Main Trigger Source	EXT
Main SLOPE	+ (positive)
Main Trigger Coupling	AC
Main TIME/DIV	0.2 μSEC
Delayed TIME/ DIV	OFF
Delayed VERNIER	CAL
Delayed Trigger Source	EXT
Delayed SLOPE	+ (positive)
Delayed Trigger Coupling	AC

5-12. TRIGGERING.

a. Connect Signal Generator output and RF Voltmeter input to Channel A Input and Main EXT INPUT as shown is Figure 5-1.

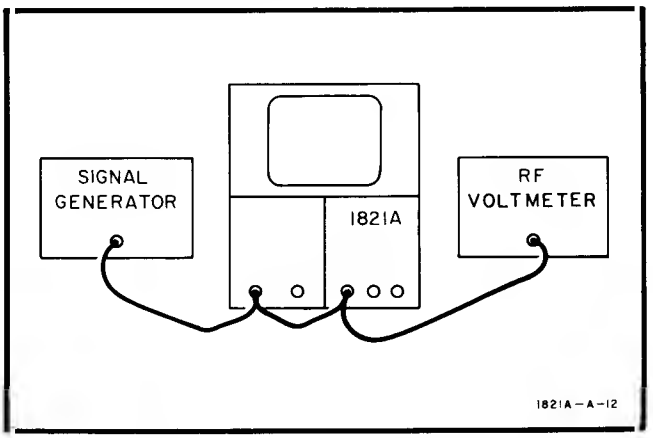


Figure 5-1. Main Triggering Test Set-Up

b. Adjust Signal Generator for a 50 MHz signal at 0.5 v pk-pk (0.35 v rms).

c. Adjust Intensity and position controls if necessary to obtain a display.

d. Adjust Main TRIGGER LEVEL to obtain a stable display.

e. Adjust Signal Generator for a 90 MHz signal at 1 v pk-pk (0.7 v rms).

f. Adjust Main TRIGGER LEVEL to obtain a stable display.

g. Connect Signal Generator output and RF Voltmeter input to Channel A Input, Main EXT INPUT, and Delayed EXT INPUT as shown in Figure 5-2.

h. Set Sweep Display to DELAYED and Delayed TIME/DIV to 0.1 μSEC.

i. Adjust Signal Generator for a 50 MHz signal at 0.5 v pk-pk (0.35 v rms).

j. Adjust Delayed TRIGGER LEVEL to obtain a stable display.

k. Adjust Signal Generator for a 90 MHz signal at 1 v pk-pk (0.7 v rms).

m. Adjust Delayed TRIGGER LEVEL to obtain a stable display.

n. Disconnect Signal Generator.

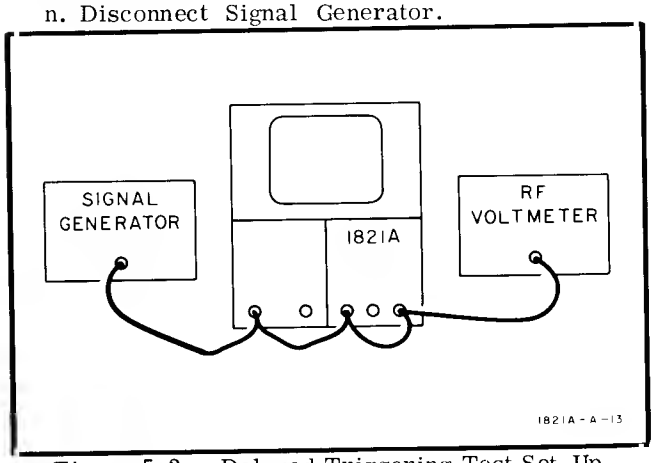


Figure 5-2. Delayed Triggering Test Set-Up

5-13. TRIGGER POINT AND SLOPE.

a. Set: MAGNIFIER · · · · · · · · · · · · · · X1
Sweep Display · · · · · · · · · · · · MAIN
Main TIME/DIV · · · · · · · · · · 5 MSEC
Delayed TIME/DIV · · · · · · · · · · OFF
Channel A Volts/div · · · · · · · · · 1

b. Connect a 40 Hz, 5 volt pk-pk ac signal from Oscillator output to Channel A Input, Main EXT INPUT, and Delayed EXT INPUT.

c. Adjust Main TRIGGER LEVEL. Note that display is stable as trigger point moves smoothly along positive slope of waveform.

d. Set Main SLOPE to - (negative).

e. Adjust Main TRIGGER LEVEL. Note that display is stable as trigger point moves smoothly along negative slope of waveform.

f. Set Sweep Display switch to DELAYED and Delayed TIME/DIV switch to 2 MSEC.

g. Adjust Delayed TRIGGER LEVEL. Note that display is stable as trigger point moves smoothly along positive slope of waveform.

h. Set Delayed SLOPE to - (negative).

i. Adjust Delayed TRIGGER LEVEL. Note that display is stable as trigger point moves smoothly along negative slope of waveform.

j. Disconnect Oscillator.

Note

The results of checks made in Paragraphs 5-14 through 5-19 are determined by the calibration of both the Model 1821A and the Model 180-series Oscilloscope.

5-14. MAIN SWEEP TIME.

a. Connect Time Mark Generator output to Channel A Input.

b. Set: Sweep Display · · · · · · · · · · · MAIN
Delayed TIME/DIV · · · · · · · · · OFF
SWEEP MODE · · · · · · · · · · · NORM
Main Trigger Source · · · · · · · · · INT
Main SLOPE · · · · · · · · · + (positive)
Channel A Volts/div · · · · · · · · 0.5

c. Set Time Mark Generator and Main TIME/CM switch according to Table 5-2. Adjust Main TRIGGER LEVEL for display.

d. Adjust Horizontal POSITION to align first marker with left edge of graticule.

e. The 11th or 21st marker (according to Table 5-2), is within 0.3 div of right edge of graticule.

Table 5-2. Main Sweep Performance

Time Mark Generator	Main TIME/DIV Setting	Time Mark to Check
0.1 μsec	0.1 μSEC	11
1 μsec	1 μSEC	11
10 μsec	10 μSEC	11
0.1 msec	0.1 MSEC	11
1 msec	1 MSEC	11
10 msec	10 MSEC	11
10 msec	20 MSEC	21
1 sec	1 SEC	11

5-15. MAIN SWEEP VERNIER.

a. Set Time Mark Generator for 0.5 sec markers.

b. Set Main TIME/DIV to 50 MSEC and rotate Main VERNIER fully ccw.

c. Any two markers are displayed in less than 4 div.

5-16. MAGNIFIED SWEEP.

a. Set: Horizontal MAGNIFIER · · · · · · · · X5
Main TIME/DIV · · · · · · · 0.1 μSEC
Main VERNIER · · · · · · · · · · · CAL

b. Set Time Mark Generator to 20 nsec. Adjust Main TRIGGER LEVEL if necessary for display.

c. Adjust Horizontal Position to align peak of first cycle with left edge of graticule.

d. Peak of 11th cycle is within 0.5 mm of right edge of graticule.

e. Set Horizontal MAGNIFIER to X10 and Time Mark Generator to 10 nsec.

f. Adjust Horizontal Position to align peak of first cycle with left edge of graticule.

g. Peak of 11th cycle is within 0.5 div of right edge of graticule.

5-17. DELAYED SWEEP TIME.

a. Set: Main VERNIER · · · · · · · · · · · CAL
Main TIME/DIV · · · · · · 0.2 μSEC
Sweep Display · · · · · · · · DELAYED
Delayed Trigger Source · · · · · · INT
Delayed Slope · · · · · · · · · + (positive)

b. Set Time Mark Generator and delayed TIME/DIV according to Table 5-3. Adjust Delayed TRIGGER LEVEL for display.

c. Adjust Horizontal POSITION to align first marker with left edge of graticule.

d. The 11th or 21st marker (according to Table 5-3) is within 0.3 div of right edge of graticule.

Table 5-3. Delayed Sweep Performance

Time Mark Generator	Delayed TIME/DIV Setting	Time Mark to Check
0.1 μsec	0.1 μSEC	11
1 μsec	1 μSEC	11
10 μsec	10 μSEC	11
0.1 msec	0.1 MSEC	11
1 msec	1 MSEC	11
1 msec	2 MSEC	21
50 msec	50 MSEC	11

5-18. DELAYED SWEEP VERNIER.

a. Set Delayed TIME/DIV to 50 MSEC and rotate Delayed VERNIER fully ccw.

b. Set Time Mark Generator for 0.5 sec markers.

c. Any two markers are displayed in less than 4 cm.

5-19. DELAY TIME ACCURACY.

a. Set: Sweep Display . . . . . MAIN
Main TIME/DIV . . . . . 1 MSEC
Delayed TIME/DIV . . . . . 10 μSEC
Delayed Trigger Source. . . . . AUTO
Delayed VERNIER. . . . . CAL

b. Set Time Mark Generator for 1 msec markers.

c. Adjust Main TRIGGER LEVEL for display.

d. Adjust DELAY (DIV) to intensify 2nd marker.

e. Position Sweep Display to DELAYED.

f. Adjust DELAY (DIV) to set visible marker 1 div from start of display. Note DELAY (DIV) settings.

g. Set Sweep Display to MAIN and adjust DELAY (DIV) to intensify 10th marker.

h. Set Sweep Display to DELAYED.

i. Adjust DELAY (DIV) to set visible marker 1 div from start of display. Note DELAY (DIV) setting.

j. Difference between DELAY (DIV) settings in steps d and f is 8.00 ± 0.08.

5-20. DELAY TIME LINEARITY.

a. Rotate DELAY (DIV) cw from 0.00 and adjust to set first visible marker 1 div from start of display. Note DELAY (DIV) setting.

b. Adjust DELAY (DIV) to set 5th visible marker 1 div from start of display. Note DELAY (DIV) setting.

c. Adjust DELAY (DIV) to set 9th visible marker 1 div from start of sweep. Note DELAY (DIV) setting.

d. Subtract the setting in step a from the setting in step c - Divide the difference by 2 - Add this result to the setting in step a - Subtract from this sum the setting of step b - Divide this result by 2.

e. Answer is 0 ± 0.02.

A = step a
B = step b
C = step c

$$\frac{A + \frac{C - A}{2} - B}{2} = 0 \pm .02$$

5-21. JITTER.

a. Set Delayed TIME/DIV to 1μSEC.

b. Adjust DELAY (DIV) to view the 9th visible marker.

c. Observe that horizontal jitter is less than 0.5 div.

5-22. DELAYED TRIGGER OUTPUT.

a. Connect DEL'D TRIGGER OUTPUT through a 10:1 Divider Probe to the monitor Oscilloscope.

b. Observe a positive pulse greater than 1 volt in amplitude and with a rise time of less than 50 nsec.

5-23. MIXED SWEEP.

a. Set: Sweep Display . . . . . MIXED
Main TIME/DIV . . . . . 1 MSEC
Delayed TIME/DIV 5.00

b. Observe that first part of display is brighter than last part.

c. Disconnect Time Mark Generator.

5-24. SINGLE SWEEP.

a. Set: Sweep Display. . . . . MAIN
SWEEP MODE . . . . . SINGLE
Main TIME/DIV . . . . . 0.1 SEC
Delayed TIME/DIV . . . . . OFF

b. Depress RESET. RESET lamp lights.

c. Rotate Main TRIGGER LEVEL fully cw and then fully ccw.

d. Beam should sweep only once. RESET lamp extinguishes at end of sweep.

5-25. ADJUSTMENTS.

5-26. Procedures for making adjustment in the Model 1821A are given in Paragraphs 5-27 through 5-36. Required test equipment is listed in Table 5-1. Test equipment with similar characteristics may be substituted if necessary. Figure 8-2 shows the location of adjustments in the Model 1821A.

5-27. PRELIMINARY.

5-28. Lock plug-ins together and install in Model 180-series Oscilloscope. Apply power and allow a fifteen minute warm-up. Set front panel adjustment, INTENS RATIO, to midrange before attempting adjustment procedure.

5-29. INITIAL CONTROL SETTINGS.

a. Model 180-series Oscilloscope:

MAGNIFIER X1
Horizontal DISPLAY . . . . . INT

b. Vertical Plug-In (set controls as applicable).

Vertical DISPLAY	.A
Channel A Polarity	+UP
Channel A Vernier	CAL
Channel A Volts/div	.05
Channel A Coupling	AC

c. Model 1821A Time Base:

Sweep Display	MAIN
SWEEP MODE	SINGLE
DELAY (DIV)	1.00
Main VERNIER	CAL
Main Trigger Source	EXT
Main SLOPE	+ (positive)
Main Trigger Coupling	AC
Main TIME/DIV	1 MSEC
Delayed TIME/DIV	OFF
Delayed VERNIER	CAL
Delayed Trigger Source	EXT
Delayed SLOPE	+ (positive)
Delayed Trigger Coupling	AC

5-30. OUTPUT LEVEL.

a. Monitor TP204 (see Figure 8-2) with DC Voltmeter.

b. Adjust R238 for 0 vdc ± 15 mv.

c. Set Delayed TIME/DIV to 0.1 MSEC.

d. Monitor TP404 (see Figure 8-2)with a DC Voltmeter.

e. Adjust R422 for 0 vdc ± 15 mv.

5-31. TRIGGER SYMMETRY.

a. Rotate Delayed TIME/DIV to OFF and set SWEEP MODE to AUTO.

b. Connect a 1 kHz 200 mv pk-pk signal from Oscillator output to Channel A Input, Main EXT INPUT, and Delayed EXT INPUT.

c. Center Main TRIGGER LEVEL control exactly.

d. Adjust R127 to obtain a stable display.

e. Set Sweep Display to DELAYED and Delayed TIME/DIV to 0.5 MSEC.

f. Center Delayed TRIGGER LEVEL control exactly.

g. Adjust R318 to obtain a display.

5-32. MAIN SWEEP LENGTH.

a. Set:

Sweep Display	MAIN
Delayed TIME/DIV	OFF
Channel A Volts/div	0.5

b. Adjust Oscillator output for a 100 kHz 3v pk-pk signal.

c. Set Main TRIGGER LEVEL for shortest horizontal display.

d. Adjust R251 for a horizontal display of 10 div.

e. Adjust Horizontal POSITION to place right side of display on ninth graticule line. Readjust R251 to increase display length 0.4 div (this gives a total display length of 10.4 div).

5-33. DELAYED SWEEP LENGTH.

a. Set Sweep Display to DELAYED and Delayed TIME/DIV to 0.5 MSEC.

b. Set Delayed TRIGGER LEVEL for the shortest horizontal display.

c. Adjust R435 for a 10 cm horizontal display.

d. Adjust Horizontal POSITION to place right side of display on eighth graticule line. Readjust R435 to increase display length 1.5 div (this gives a total display length of 11.5 div).

e. Disconnect Oscillator.

5-34. MAIN SWEEP TIME.

a. Set:

Sweep Display	MAIN
Delayed TIME/DIV	OFF
SWEEP MODE	NORM
Main Trigger Source	INT

b. Connect Time Mark Generator to Channel A Input.

c. Set Time Mark Generator and Main TIME/DIV switch as indicated in Table 5-4. Adjust Main TRIGGER LEVEL for display.

d. Adjust Horizontal POSITION to align 1st marker with left edge of graticule.

e. Perform adjustment specified in Table 5-4 to align 11th marker with right edge of graticule.

Table 5-4. Main Sweep Time

Time Mark Generator	Main TIME/DIV Setting	Time Mark to Adjust	Adjust
0.1 μsec	0.1 μSEC	11	C510
1 μsec	1 μSEC	11	C508
5 μsec	5 μSEC	11	C506
50 μsec	50 μSEC	11	R516
500 μsec	0.5 MSEC	11	R515
5 msec	5 MSEC	11	R514
50 msec	50 MSEC	11	R513

5-35. DELAYED SWEEP TIME.

a. Set:

Sweep Display	.DELAYED
Main TIME/DIV	0.2 μSEC
Delayed Trigger Source	INT

b. Set Time Mark Generator and Main TIME/CM as indicated in Table 5-5. Adjust Delayed TRIGGER LEVEL for display.

c. Adjust Horizontal POSITION to align 1st marker with left edge of graticule.

d. Perform adjustment specified in Table 5-5 to align 11th marker with right edge of graticule.

Table 5-5. Delayed Sweep Time

Time Mark Generator	Delayed TIME/DIV Setting	Time Mark to Adjust	Adjust
0.1 μsec	0.1 μSEC	11	C532
1 μsec	1 μSEC	11	C530
5 μsec	5 μSEC	11	C528
50 μsec	50 μSEC	11	R539
500 μsec	0.5 MSEC	11	R538
5 msec	5 MSEC	11	R537

5-36. SWEEP COMPARATOR.

a. Set:

Main TIME/DIV	1 MSEC
Delayed TIME/DIV	10 μSEC
Delayed Trigger Source	AUTO
DELAY (DIV)	0.00

b. Set Time Mark Generator for 1 msec markers.

c. Rotate DELAY (DIV) cw from 0.00 until first marker appears. Set DELAY (DIV) to 1.00 and adjust R473 to set first marker 1 div from start of display.

d. Rotate DELAY (DIV) cw from 0.00 until ninth marker appears. Set DELAY (DIV) to 9.00 and adjust R469 to set ninth marker 1 div from start of display.

e. Repeat steps c and d until no further adjustment is necessary.

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PERFORMANCE CHECK RECORD

Serial Number: _____

Paragraph	Check	Result		
		Minimum	Reading	Maximum
5-12	Triggering			
step d	main @ 50 MHz	0.5 v pk-pk	_____	
" f	main @ 90 MHz	1 v pk-pk	_____	
" j	delayed @ 50 MHz	0.5 v pk-pk	_____	
" m	delayed @ 90 MHz	1 v pk-pk	_____	
5-13	Triggering Point and Slope			
step c	main + (positive)	stable on positive slope	_____	
" e	main - (negative)	stable on negative slope	_____	
" g	delayed + (positive)	stable on positive slope	_____	
" i	delayed - (negative)	stable on negative slope	_____	
5-14	Main Sweep Time			
	0.1 μSEC	9.7 div	_____	10.3 div
	1 μSEC	9.7 div	_____	10.3 div
	10 μSEC	9.7 div	_____	10.3 div
	0.1 MSEC	9.7 div	_____	10.3 div
	1 MSEC	9.7 div	_____	10.3 div
	10 MSEC	9.7 div	_____	10.3 div
	20 MSEC	9.7 div	_____	10.3 div
	1 SEC	9.7 div	_____	10.3 div
5-15	Main Sweep Vernier		_____	4 div
5-16	Magnified Sweep			
step d	X5	9.5 div	_____	10.5 div
" g	X10	9.5 div	_____	10.5 div
5-17	Delayed Sweep Time			
	0.1 μSEC	9.7 div	_____	10.3 div
	1 μSEC	9.7 div	_____	10.3 div
	10 μSEC	9.7 div	_____	10.3 div
	0.1 MSEC	9.7 div	_____	10.3 div
	1 MSEC	9.7 div	_____	10.3 div
	2 MSEC	9.7 div	_____	10.3 div
	50 MSEC	9.7 div	_____	10.3 div
5-18	Delayed Sweep Vernier		_____	4 div
5-19	Delay Time Accuracy	7.92	_____	8.08
5-20	Delay Time Linearity	-.02	_____	+.02

PERFORMANCE CHECK RECORD (Cont'd)

Paragraph	Check	Result		
		Minimum	Reading	Maximum
5-21	Jitter			0.5 div
5-22	Delayed Trigger Output			
	amplitude	1.5 v		
	rise time			50 nsec
5-23	Mixed Sweep	1st part brighter		
5-24	Single Sweep			
step b		lamp lights		
" d		one sweep		

SECTION VI
REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for ordering replaceable parts for the instrument. Table 6-2 lists the parts in alpha-numerical order of their reference deisgnations and provides the following information for each item:

a. hp Part Number.

b. Total quantity (TQ) used in instrument; given only first time a part number is listed.

c. Description of part; see Table 6-1 for list of reference designators and abbreviations.

6-3. Parts not identified by a reference designation are listed at the end of Table 6-2, under Miscellaneous.

6-4. ORDERING INFORMATION.

6-5. To order replacement parts from the Hewlett-Packard Company, address the order or inquiry to the nearest Hewlett-Packard Sales/Service Office (list at the rear of manual) and supply the following information:

a. hp Part Number of item(s).

b. Model number and eight-digit number of the instrument.

c. Quantity of parts desired.

6-6. To order a part not listed in the table, provide the following information:

a. Model number and eight-digit serial number of instrument.

b. Description of part including function and location.

6-7. Component descriptions given in Table 6-2 are as complete as possible to assist in obtaining replacement parts from manufacturers other than hp. However, many parts are manufactured only by hp, or are produced by other manufacturers to hp proprietary specifications, and are therefore available only from hp. Actual manufacturer and manufacturers part number for non-hp parts will be supplied upon request. Contact the nearest hp Sales/Service Office.

Table 6-1. Reference Designators and Abbreviations

REFERENCE DESIGNATORS

A = assembly	F = fuse	MP = mechanical part	TP = test point
B = motor	FL = filter	P = plug	V = vacuum tube, neon bulb, photocell, etc.
C = capacitor	J = jack	Q = transistor	
CP = coupling	K = relay	R = resistor	VR = voltage regulator (diode)
CR = diode	L = inductor	RT = thermistor	
DL = delay line	LS = speaker	S = switch	W = cable
DS = device signaling (lamp)	M = meter	T = transformer	X = socket
E = misc electronic part	MC = microcircuit	TB = terminal board	Y = crystal

ABBREVIATIONS

A = amperes	GL = glass	MTG = mounting	RF = radio frequency
AMPL = amplifier	GRD = ground(ed)	MY = "mylar"	S-B = slow-blow
	H = henries	N = nano (10^{-9})	SCR = screw
BP = bandpass	HG = mercury	N/C = normally closed	SE = selenium
	HR = hour(s)	NE = neon	SECT = section(s)
CAR = carbon	hp = Hewlett-Packard	N/O = normally open	SEMICON = semiconductor
CCW = counterclockwise		NPO = negative positive zero (zero temperature coefficient)	SI = silicon
CER = ceramic	IF = intermediate freq.		SIL = silver
COEF = coefficient	IMPG = impregnated		SL = slide
COM = common	INCD = incandescent	NSR = not separately replaceable	SPL = special
COMP = composition	INCL = include(s)		
CONN = connector	INS = insulation(ed)		TA = tantalum
CRT = cathode-ray tube	INT = internal	OBD = order by description	TD = time delay
CW = clockwise		OX = oxide	TGL = toggle
	K = kilo = 1000		TI = titanium
DEPC = deposited carbon		PC = printed circuit	TOL = tolerance
	LIN = linear taper	PF = picofarads = 10^{-12} farads	TRIM = trimmer
ELECT = electrolytic	LOG = logarithmic taper		
ENCAP = encapsulated	LPF = low pass filter	PIV = peak inverse voltage	μ = micro = 10^{-6}
EXT = external		P/O = part of	
	M = milli = 10^{-3}	POLY = polystyrene	VAR = variable
F = farads	MEG = meg = 10^{6}	PORC = porcelain	VDCW = dc working volts
FET = field effect transistor	METFLM = metal film	POS = position(s)	
	MET OX = metal oxide	POT = potentiometer	W = with
FXD = fixed	MFR = manufacturer	PK-PK = peak-to-peak	W = watts
	MINAT = miniature		WW = wirewound
GE = germanium	MOM = momentary	RECT = rectifier	W/O = without

Table 6-2. Replaceable Parts

Ref Desig	hp Part No.	RS	TQ	Description (See Table 6-1.)
A1	01821-66508		1	A: sweep control board
A2	01821-66507		1	A: sweep board
A3	01821-61904		1	A: sweep time (includes A2, S501-S503)
C100	0160-0134		1	C: fxd mica 220 pf 5%
C101	0160-2241		1	C: fxd my 2.2 pf ±.25 pf 500vdcw
C102	0180-0155		15	C: fxd ta elect 2.2 µf 20% 20vdcw
C103	0140-0145		3	C: fxd mica 22 pf 5% 500vdcw
C104	0180-0155			C: fxd ta elect 2.2 µf 20% 20vdcw
C105	0150-0024		2	C: fxd cer .02 µf -20% +80% 600vdcw
C106	0150-0051		2	C: fxd cer 100 pf 600vdcw
C107	0160-0153		1	C: fxd my 1000 pf 10%
C108	0140-0149		2	C: FXD MICA 470PF 5% 300VDCW
C109	0160-0161		3	C: fxd my .01 µf 10%
C111	0180-0155			C: fxd ta elect 2.2 µf 20% 20vdcw
C112	0160-2959		4	C: fxd cer 1000 pf -0+100% 600vdcw
C113	0160-2959			C: fxd cer 1000 pf -0+100% 600vdcw
C117	0160-0168		4	C: fxd my .1 µf 10%
C118	0140-0176		7	C: fxd mica 100 pf 2% 300vdcw
C119	0140-0203		5	C: fxd mica 30 pf 5% 500vdcw
C120	0180-0155			C: fxd ta elect 2.2 µf 20% 20vdcw
C121	0140-0176			C: fxd mica 100 pf 2% 300vdcw
C122	0180-0155			C: fxd ta elect 2.2 µf 20% 20vdcw
C123	0180-0155			C: fxd ta elect 2.2 µf 20% 20vdcw
C201	0140-0176			C: fxd mica 100 pf 2% 300vdcw
C202	0140-0145			C: fxd mica 22 pf 5% 500vdcw
C203	0180-0155			C: fxd ta elect 2.2 µf 20% 20vdcw
C204	0150-0042		2	C: fxd ti 4.7 pf 5% 500vdcw
C205	0140-0176			C: fxd mica 100 pf 2% 300vdcw
C206	0160-0161			C: fxd my .01 µf 10%
C207	0160-0168			C: fxd my 0.1 µf 10%
C208	0170-0040		1	C: fxd my .047 µf 10% 200vdcw
C209	0140-0220		1	C: fxd mica 200 pf 1% 300vdcw
C211	0140-0191		1	C: fxd mica 56 pf 5% 300vdcw
C213	0160-0162		15	C: fxd my .022 µf 10%
C214	0180-0155			C: fxd ta elect 2.2 µf 20% 20vdcw
C215	0160-0162			C: fxd my .022 µf 10%
C216	0160-0162			C: fxd my .022 µf 10%
C217	0140-0203			C: fxd mica 30 pf 5% 500vdcw
C218	0140-0156		2	C: fxd mica 1500 pf 2% 300vdcw
C219	0160-2263		2	C: fxd cer 18 pf 5% 500vdcw
C220	0160-0162			C: fxd my .022 µf 10%
C301	0160-2239		1	C: fxd my 1.8 pf ±.25 pf 500vdcw
C302	0150-0024			C: fxd cer .02 µf -20% +80% 600vdcw
C303	0150-0051			C: fxd cer 100 pf 600vdcw
C307	0160-0161			C: fxd my .01 µf 10%
C308	0180-0155			C: fxd ta elect 2.2 µf 20% 20vdcw
C310	0160-0162			C: fxd my .022 µf 10%
C311	0160-2959			C: fxd cer 1000 pf -0+100% 600vdcw

Table 6-2. Replaceable Parts (Cont'd)

Ref Desig	hp Part No.	RS	TQ	Description (See Table 6-1.)
C312	0160-2959			C: fxd cer 1000 pf -0+100% 600vdcw
C316	0160-0168			C: fxd my . 1 μf 10%
C317	0140-0176			C: fxd mica 100 pf 2% 300vdcw
C318	0140-0203			C: fxd mica 30 pf 5% 500vdcw
C319	0180-0155			C: fxd ta elect 2.2 μf 20% 20vdcw
C320	0180-0155			C: fxd ta elect 2.2 μf 20% 20vdcw
C323	0180-0155			C: fxd ta elect 2.2 μf 20% 20vdcw
C324	0160-0162			C: fxd my . 022 μf 10%
C325	0160-0162			C: fxd my . 022 μf 10%
C326	0160-0162			C: fxd my . 022 μf 10%
C327	0180-2104		2	C: fxd ta elect 40 μf 20% 30vdcw
C328	0180-2104			C: fxd ta elect 40 μf 20% 30vdcw
C401	0140-0176			C: fxd mica 100 pf 2% 300vdcw
C402	0140-0145			C: fxd mica 22 pf 5% 500vdcw
C403	0160-0162			C: fxd my . 022 μf 10%
C404	0160-0162			C: fxd my . 022 μf 10%
C405	0160-0162			C: fxd my . 022 μf 10%
C406	0140-0203			C: fxd mica 30 pf 5% 500vdcw
C407	0140-0156			C: fxd mica 1500 pf 2% 300vdcw
C408	0140-0190		1	C: fxd mica 39 pf 5% 300vdcw
C409	0160-0162			C: fxd my . 022 μf 10%
C413	0140-0203			C: fxd mica 30 pf 5% 500vdcw
C414	0140-0214		1	C: fxd mica 60 pf 5% 300vdcw
C415	0160-0162			C: fxd my . 022 μf 10%
C416	0150-0042			C: fxd ti 4.7 pf 5% 500vdcw
C417	0140-0176			C: fxd mica 100 pf 2% 300vdcw
C418	0150-0055		1	C: fxd ti 10 pf 5% 500vdcw
C419	0160-0162			C: fxd my . 022 μf 10%
C420	0180-0155			C: fxd ta elect 2.2 μf 20% 20vdcw
C421	0180-0155			C: fxd ta elect 2.2 μf 20% 20vdcw
C422	0140-0145			C: fxd mica 22 pf 5% 500vdcw
C423	0160-0168			C: fxd my . 1 μf 10%
C424	0160-0162			C: fxd my . 022 μf 10%
C425	0180-0341		1	C: fxd elect 25 μf -10% +75% 12vdcw
C426	0180-0216		1	C: fxd ta elect 12 μf 10% 35vdcw
C501	0160-2433		1	C: fxd poly 1 μf 5% 100vdcw
C502	0160-2432		2	C: fxd poly . 1 μf 5% 100vdcw
C503	0160-2431		2	C: fxd poly . 01 μf 5% 100vdcw
C504	0160-2430		2	C: fxd poly . 001 μf 5% 100vdcw
C505	0140-0215		2	C: fxd mica 80 pf 2% 300vdcw
C506	0121-0061		4	C: var cer 5.5-18 pf 300vdcw
C507	0160-2200		2	C: fxd mica 43 pf 5% 500vdcw
C508	0121-0061			C: var cer 5.5-18 pf 300vdcw
C509	0160-2264		1	C: fxd cer 20 pf 5% 500vdcw
C510	0121-0060		2	C: var cer 2-8 pf

Table 6-2. Replaceable Parts (Cont'd)

Ref Desig	hp Part No.	RS	TQ	Description (See Table 6-1.)		
C514	0180-0155			C: fxd ta elect 2.2 µf 20% 20vdcw		
C515	0180-0218			C: fxd ta elect .15 µf 10% 35vdcw		
C516	0170-0024		1	C: fxd my .022 µf 20% 200vdcw		
C517	0160-0299		1	C: fxd my 1800 pf 10% 200vdcw		
C518	0150-0072		1	C: fxd cer 200 pf 5% 500vdcw		
C519	0150-0073		1	C: fxd cer 100 pf 10% 500vdcw		
C520	0150-0078		1	C: fxd cer 56 pf 10% 1000vdcw		
C524	0160-2432			C: fxd poly .1 µf 5% 100vdcw		
C525	0160-2431			C: fxd poly .01 µf 5% 100vdcw		
C526	0160-2430			C: fxd poly .001 µf 5% 100vdcw		
C527	0140-0215			C: fxd mica 80 pf 2% 300vdcw		
C528	0121-0061			C: var cer 5.5-18 pf 300vdcw		
C529	0160-2200			C: fxd mica 43 pf 5% 500vdcw		
C530	0121-0061			C: var cer 5.5-18 pf 300vdcw		
C531	0160-2263			C: fxd cer 18 pf 5% 500vdcw		
C532	0121-0060			C: var cer 2-8 pf		
CR103	1901-0096		7	CR: si		
CR104	1910-0016		12	CR: ge		
CR105	1910-0016			CR: ge		
CR106	1912-0004		2	CR: ge tunnel 5 ma		
CR107	1901-0040		32	CR: si		
CR108	1901-0040			CR: si		
CR109	1901-0040			CR: si		
CR110	1901-0040			CR: si		
CR114	1901-0040			CR: si		
CR115	1901-0040			CR: si		
CR116	1901-0040			CR: si		
CR117	1901-0040			CR: si		
CR201	1912-0006		2	CR: ge tunnel 10 ma		
CR202	1910-0016			CR: ge		
CR203	1901-0040			CR: si		
CR204	1901-0040			CR: si		
CR205	1910-0016			CR: ge		
CR206	1910-0016			CR: ge		
CR207	1901-0040			CR: si		
CR210	1901-0040			CR: si		
CR211	1901-0439		2	CR: si		
CR212	1901-0096			CR: si		
CR213	1901-0040			CR: si		
CR214	1901-0040			CR: si		
CR215	1901-0050		2	CR: si		
CR216	1901-0040			CR: si		
CR217	1901-0040			CR: si		
CR218	1901-0040			CR: si		
CR219	1901-0040			CR: si		
CR220	1901-0096			CR: si		

Table 6-2. Replaceable Parts (Cont'd)

Ref Desig	hp Part No.	RS	TQ	Description (See Table 6-1.)		
CR301	1901-0096			CR: si		
CR302	1910-0016			CR: ge		
CR303	1910-0016			CR: ge		
CR304	1912-0004			CR: ge tunnel 5 ma		
CR305	1901-0040			CR: si		
CR306	1901-0040			CR: si		
CR307	1901-0040			CR: si		
CR308	1901-0040			CR: si		
CR309	1901-0096			CR: si		
CR401	1912-0006			CR: ge tunnel 10 ma		
CR402	1910-0016			CR: ge		
CR403	1901-0040			CR: si		
CR404	1901-0040			CR: si		
CR405	1910-0016			CR: ge		
CR406	1910-0016			CR: ge		
CR410	1901-0040			CR: si		
CR411	1901-0439			CR: si		
CR412	1901-0040			CR: si		
CR413	1901-0050			CR: si		
CR414	1901-0096			CR: si		
CR415	1901-0040			CR: si		
CR416	1901-0040			CR: si		
CR420	1910-0016			CR: ge		
CR421	1910-0016			CR: ge		
CR422	1901-0040			CR: si		
CR423	1912-0007		1	CR: tunnel		
CR424	1901-0040			CR: si		
CR425	1901-0040			CR: si		
CR501	1901-0096			CR: si		
CR502	1901-0040			CR: si		
DS201				NSR: p o S201		
J1	1251-0054		1	J: female 24 pin		
J101	1250-0083		3	J: BNC female		
J301	1250-0083			J: BNC female		
J401	1250-0083			J: BNC female		
L102	9140-0047		8	L: fxd 20 μh		
L103	9140-0047			L: fxd 20 μh		
L104	9170-0029		6	L: bead ferrite		
L107	9140-0047			L: fxd 20 μh		
L108	9170-0029			L: bead ferrite		
L109	9140-0088		2	L: fxd 0.33 μh		
L110	9140-0047			L: fxd 20 μh		

Table 6-2. Replaceable Parts (Cont'd)

Ref Desig	hp Part No.	RS	TQ	Description (See Table 6-1.)
L201	9140-0047			L: fxd 20 μh
L202	9140-0115		3	L: fxd 22 μh
L203	9170-0029			L: bead ferrite
L301	9170-0029			L: bead ferrite
L302	9140-0047			L: fxd 20 μh
L303	9170-0029			L: bead ferrite
L304	9140-0088			L: fxd 0.33 μh
L305	9140-0047			L: fxd 20 μh
L306	9140-0047			L: fxd 20 μh
L308	9140-0115			L: fxd 22 μh
L309	9140-0115			L: fxd 22 μh
L402	9170-0029			L: bead ferrite
P1	1251-0136		1	P: 32 pin male
P2	1250-0898		1	P: bulkhead connector 1 pin female
Q101	1854-~~0206~~ 0215		1	Q: si npn
Q102	1853-0036		3	Q: si pnp
Q103	1855-0020		5	Q: si fet
Q104	1854-0215		8	Q: si npn
Q105	1854-0215			Q: si npn
Q106	1853-0009		2	Q: si pnp
Q107	1850-0164		2	Q: ge pnp
Q108	1854-0009		2	Q: si npn
Q109	1854-0019		9	Q: si npn
Q110	1853-0049		2	Q: si pnp
Q111	1853-0049			Q: si pnp
Q112	1854-0019			Q: si npn
Q201	1850-0099		2	Q: ge pnp
Q202	1854-0019			Q: si npn
Q203	1854-0022		5	Q: si npn
Q204	1854-0019			Q: si npn
Q205	1854-0019			Q: si npn
Q206	1853-0036			Q: si pnp
Q207	1855-0020			Q: si fet
Q208	1854-0215			Q: si npn
Q209	1854-0022			Q: si npn
Q210	1854-0215			Q: si npn
Q211	1854-0215			Q: si npn
Q301	1855-0020			Q: si fet
Q302	1854-0215			Q: si npn
Q303	1854-0215			Q: si npn
Q304	1853-0009			Q: si pnp
Q305	1850-0164			Q: ge pnp
Q306	1854-0009			Q: si npn
Q401	1850-0099			Q: ge pnp
Q402	1854-0019			Q: si npn
Q403	1854-0019			Q: si npn
Q404	1854-0019			Q: si npn
Q405	1853-0036			Q: si pnp

Table 6-2. Replaceable Parts (Cont'd)

Ref Desig	hp Part No.	RS	TQ	Description (See Table 6-1.)
Q406	1855-0020			Q: si fet
Q407	1854-0215			Q: si npn
Q408	1854-0022			Q: si npn
Q409	1854-0019			Q: si npn
Q410	1850-0158		1	Q: ge pnp
Q411	1854-0022			Q: si npn
Q412	1855-0020			Q: si fet
Q413	1854-0022			Q: si npn
R101	0757-0290		1	R: fxd metflm 6.19k ohms 1% 1/8w
R102	0757-0290		3	R: fxd metflm 6.19k ohms 1% 1/8w
R103	0698-~~5472~~ 8480		2	R: fxd metflm 900k ohms 1% 1/8w
R104	0757-0466		4	R: fxd metflm 110k ohms 1% 1/8w
R105	0683-0275		3	R: fxd metflm 2.7 ohms 5% 1/4w
R106	0757-0438		8	R: fxd metflm 5.11k ohms 1% 1/8w
R107	0757-0401		11	R: fxd metflm 100 ohms 1% 1/8w
R108	0757-0414		7	R: fxd metflm 432 ohms 1% 1/8w
R109	0757-0346		3	R: fxd metflm 10 ohms 1% 1/8w
R110	0757-0280		5	R: fxd metflm 1k ohms 1% 1/8w
R111	0757-0407		1	R: fxd metflm 200 ohms 1% 1/8w
R112	0757-0344		2	R: fxd metflm 1 megohm 1% 1/4w
R113	0757-0465		~~8~~ 6	R: fxd metflm 100k ohms 1% 1/8w
R114	0757-~~0465~~ 5442		6	R: fxd metflm ~~100k~~ 10k ohms 1% 1/8w
R117	0757-0465			R: fxd metflm 100k ohms 1% 1/8w
R118	0757-0395		2	R: fxd metflm 56.2 ohms 1% 1/8w
R119	0757-0388		3	R: fxd metflm 30.1 ohms 1% 1/8w
R120	0812-0051		2	R: fxd ww 15k ohms 3% 3w
R121	2100-2001		2	R: var comp 5k ohms 10% 1/4w
R122	0757-0447		2	R: fxd metflm 16.2k ohms 1% 1/8w
R124	0757-0290			R: fxd metflm 6.19k ohms 1% 1/8w
R125	0757-0461		3	R: fxd metflm 68.1k ohms 1% 1/8w
R126	0811-1551		2	R: fxd ww 10k ohms 1% 3w
R127	2100-2489		1	R: var metflm 5k ohms 30% 1/2w lin
R130	0757-0346		3	R: fxd metflm 10 ohms 1% 1/8w
R131	0757-0392		3	R: fxd metflm 43.2 ohms 1% 1/8w
R132	0757-0398		2	R: fxd metflm 75 ohms 1% 1/8w
R133	0757-0845		6	R: fxd metflm 18.2k ohms 1% 1/2w
R134	0757-0421		2	R: fxd metflm 825 ohms 1% 1/8w
R135	0757-0414			R: fxd metflm 432 ohms 1% 1/8w
R136	0757-0436			R: fxd metflm 4.32k ohms 1% 1/8w
R137	0757-0427		6	R: fxd metflm 1.5k ohms 1% 1/8w
R138	0757-0282		3	R: fxd metflm 221 ohms 1% 1/8w
R139	0757-0413		4	R: fxd metflm 392 ohms 1% 1/8w
R140	0757-0442		~~4~~	R: fxd metflm 10k ohms 1% 1/8w
R141	0757-0419		4	R: fxd metflm 681 ohms 1% 1/8w
R145	0757-0200		1	R: fxd metflm 5.62k ohms 1% 1/8w
R146	0757-0481		3	R: fxd metflm 475k ohms 1% 1/8w
R147	0757-0414			R: fxd metflm 432 ohms 1% 1/8w
R148	0757-0416		4	R: fxd metflm 511 ohms 1% 1/8w
R149	0757-0283		1	R: fxd metflm 2k ohms 1% 1/8w

Table 6-2. Replaceable Parts (Cont'd)

Ref Desig	hp Part No.	RS	TQ	Description (See Table 6-1.)		
R150	0757-0438			R: fxd metflm 5.11k ohms 1% 1/8w		
R151	0757-0401		11	R: fxd metflm 100 ohms 1% 1/8w		
R152	0757-0427			R: fxd metflm 1.5k ohms 1% 1/8w		
R153	0757-0461			R: fxd metflm 68.1k ohms 1% 1/8w		
R154	0757-0419			R: fxd metflm 681 ohms 1% 1/8w		
R155	0757-0444		1	R: fxd metflm 12.1k ohms 1% 1/8w		
R156	0757-0273		7	R: fxd metflm 3.01k ohms 1% 1/8w		
R201	0757-0284		2	R: fxd metflm 150 ohms 1% 1/8w		
R202	0757-0413			R: fxd metflm 392 ohms 1% 1/8w		
R203	0757-0401			R: fxd metflm 100 ohms 1% 1/8w		
R204	0757-0274		2	R: fxd metflm 1.21k ohms 1% 1/8w		
R205	0757-0273			R: fxd metflm 3.01k ohms 1% 1/8w		
R206	0758-0073		2	R: fxd metflm 24k ohms 5% 1/2w		
R207	0757-0441		2	R: fxd metflm 8.25k ohms 1% 1/8w		
R208	0757-0273			R: fxd metflm 3.01k ohms 1% 1/8w		
R209	0757-0414			R: fxd metflm 432 ohms 1% 1/8w		
R210	0757-0414			R: fxd metflm 432 ohms 1% 1/8w		
R211	0757-0431		1	R: fxd metflm 2.43k ohms 1% 1/8w		
R215	0757-0471		2	R: fxd metflm 182k ohms 1% 1/8w		
R216	0757-0452		1	R: fxd metflm 27.4k ohms 1% 1/8w		
R217	0757-0481			R: fxd metflm 475k ohms 1% 1/8w		
R218	0757-0421			R: fxd metflm 825 ohms 1% 1/8w		
R219	0757-0409		1	R: fxd metflm 274 ohms 1% 1/8w		
R220	0757-0458		1	R: fxd metflm 51.1k ohms 1% 1/8w		
R221	0757-0466			R: fxd metflm 110k ohms 1% 1/8w		
R222	0757-0438			R: fxd metflm 5.11k ohms 1% 1/8w		
R223	0757-0844		2	R: fxd metflm 16.2k ohms 1% 1/2w		
R224	0757-0401			R: fxd metflm 100 ohms 1% 1/8w		
R225	0757-0442		3	R: fxd metflm 10k ohms 1% 1/8w		
R226	0757-0465			R: fxd metflm 100k ohms 1% 1/8w		
R227	0757-0280			R: fxd metflm 1k ohm 1% 1/8w		
R228	0757-0461			R: fxd metflm 68.1k ohms 1% 1/8w		
R229	0757-0768		1	R: fxd metflm 47.5k ohms 1% 1/4w		
R232	0757-0438			R: fxd metflm 5.11k ohms 1% 1/8w		
R233	0757-0417		3	R: fxd metflm 562 ohms 1% 1/8w		
R234	0683-2205		6	R: fxd comp 22 ohms 5% 1/4w		
R235	2100-2002		2	R: var car comp 50k ohms 30% 1/4w		
R236	0757-0450		1	R: fxd metflm 22.1k ohms 1% 1/8w		
R237	0757-0388			R: fxd metflm 30.1 ohms 1% 1/8w		
R238	2100-1773		2	R: var ww 1k ohm 10% 1/2w lin		
R239	0757-0428		2	R: fxd metflm 1.62k ohms 1% 1/8w		
R240	0757-0419			R: fxd metflm 681 ohms 1% 1/8w		
R241	0757-0846		1	R: fxd metflm 22.1k ohms 1% 1/2w		
R245	0683-2205			R: fxd comp 22 ohms 5% 1/4w		
R246	0757-0416			R: fxd metflm 511 ohms 1% 1/8w		
R247	0757-0405		2	R: fxd metflm 162 ohms 1% 1/8w		
R248	0757-0427			R: fxd metflm 1.5k ohms 1% 1/8w		
R249	0757-0408		2	R: fxd metflm 243 ohms 1% 1/8w		
R250	0757-0439		2	R: fxd metflm 6.81k ohms 1% 1/8w		
R251	2100-1451		2	R: var ww 2.5k ohms 5% 1w		
R252	0757-0845			R: fxd metflm 18.2k ohms 1% 1 2w		
R253	0683-2205			R: fxd comp 22 ohms 5% 1/4w		

Table 6-2. Replaceable Parts (Cont'd)

Ref Desig	hp Part No.	RS	TQ	Description (See Table 6-1.)
R254	0757-0481			R: fxd metflm 475k ohms 1% 1/8w
R255	0757-0471			R: fxd metflm 182k ohms 1% 1/8w
R256	0757-0438			R: fxd metflm 5.11k ohms 1% 1/8w
R257	0757-0461		2	R: fxd metflm 68.1k ohms 1% 1/8w
R301	0698-~~5512~~ 0400		2	R: fxd metflm 900k ohms 1% 1/8w
R302	0757-0466			R: fxd metflm 110k ohms 1% 1/8w
R303	0757-0344			R: fxd metflm 1.00 megohms 1% 1/4w
R304	0757-0465			R: fxd metflm 100k ohms 1% 1/8w
R305	0757-~~0465~~ 0442		6	R: fxd metflm ~~100k~~ 104 ohms 1% 1/8w
R307	0757-0465			R: fxd metflm 100k ohms 1% 1/8w
R308	0757-0395			R: fxd metflm 56.2 ohms 1% 1/8w
R309	0757-0388			R: fxd metflm 30.1 ohms 1% 1/8w
R310	0812-0051			R: fxd ww 15k ohms 3% 3w
R311	0757-0401			R: fxd metflm 100 ohms 1% 1/8w
R312	0811-1551			R: fxd ww 10k ohms 1% 3w
R313	2100-2001			R: var comp 5k ohms 10% 1/4w
R314	0757-0447			R: fxd metflm 16.2k ohms 1% 1/8w
R315	0757-0290			R: fxd metflm 6.19k ohms 1% 1/8w
R317	0757-0461			R: fxd metflm 68.1k ohms 1% 1/8w
R318	2100-2216		1	R: var metflm 5k ohms 30% 1/2w lin
R321	0757-0346			R: fxd metflm 10 ohms 1% 1/8w
R322	0757-0392			R: fxd metflm 43.2 ohms 1% 1/8w
R323	0757-0398			R: fxd metflm 75 ohms 1% 1/8w
R324	0757-0845			R: fxd metflm 18.2k ohms 1% 1/2w
R325	0757-0421		1	R: fxd metflm 825 ohms 1% 1/8w
R326	0757-0414			R: fxd metflm 432 ohms 1% 1/8w
R327	0757-0436			R: fxd metflm 4.32k ohms 1% 1/8w
R328	0757-0442			R: fxd metflm 10k ohms 1% 1/8w
R329	0757-0427			R: fxd metflm 1.5k ohms 1% 1/8w
R330	0757-0282			R: fxd metflm 221 ohms 1% 1/8w
R331	0757-0282			R: fxd metflm 221 ohms 1% 1/8w
R332	0757-0413			R: fxd metflm 392 ohms 1% 1/8w
R333	0757-0442			R: fxd metflm 10k ohms 1% 1/8w
R336	0757-0401			R: fxd metflm 100 ohms 1% 1/8w
R337	0757-0401			R: fxd metflm 100 ohms 1% 1/8w
R338	0757-0401			R: fxd metflm 100 ohms 1% 1/8w
R339	0683-0275			R: fxd comp 2.7 ohms 5% 1/4w
R340	0683-0275			R: fxd comp 2.7 ohms 5% 1/4w
R401	0757-0284			R: fxd metflm 150 ohms 1% 1/8w
R402	0757-0413			R: fxd metflm 392 ohms 1% 1/8w
R403	0757-0401			R: fxd metflm 100 ohms 1% 1/8w
R404	0757-0273			R: fxd metflm 3.01k ohms 1% 1/8w
R405	0757-0441			R: fxd metflm 8.25k ohms 1% 1/8w
R406	0758-0073			R: fxd metflm 24k ohms 5% 1/2w
R407	0757-0392			R: fxd metflm 43.2 ohms 1% 1/8w
R408	0757-0426		1	R: fxd metflm 1.3k ohms 1% 1/8w
R409	0757-0273			R: fxd metflm 3.01k ohms 1% 1/8w
R410	0757-0465			R: fxd metflm 100k ohms 1% 1/8w

Table 6-2. Replaceable Parts (Cont'd)

Ref Desig	hp Part No.	RS	TQ	Description (See Table 6-1.)
R411	0757-0431		1	R: fxd metflm 2.43k ohms 1% 1/8w
R412	0757-0414			R: fxd metflm 432 ohms 1% 1/8w
R413	0757-0412		1	R: fxd metflm 365 ohms 1% 1/8w
R417	0757-0417			R: fxd metflm 562 ohms 1% 1/8w
R418	0757-0438			R: fxd metflm 5.11k ohms 1% 1/8w
R419	0683-2205			R: fxd comp 22 ohms 5% 1/4w
R420	2100-2002			R: var car comp 50k ohms 30% 1/4w w/switch
R421	0757-0450		1	R: fxd metflm 22.1k ohms 1% 1/8w
R422	2100-1773			R: var ww 1k ohm 10% 1/2w lin
R423	0757-0428			R: fxd metflm 1.62k ohms 1% 1/8w
R424	0757-0419			R: fxd metflm 681 ohms 1% 1/8w
R425	0757-0846		1	R: fxd metflm 22.1k ohms 1% 1/2w
R429	0683-2205			R: fxd comp 22 ohms 5% 1/4w
R430	0757-0416			R: fxd metflm 511 ohms 1% 1/8w
R431	0757-0405			R: fxd metflm 162 ohms 1% 1/8w
R432	0757-0427			R: fxd metflm 1.5k ohms 1% 1/8w
R433	0757-0408			R: fxd metflm 243 ohms 1% 1/8w
R434	0757-0439		1	R: fxd metflm 6.81k ohms 1% 1/8w
R435	2100-1451			R: var ww 2.5k ohms 5% 1w
R436	0757-0845			R: fxd metflm 18.2k ohms 1% 1/2w
R437	0683-2205			R: fxd comp 22 ohms 5% 1/4w
R441	0757-0416			R: fxd metflm 511 ohms 1% 1/8w
R442	0757-0466			R: fxd metflm 110k ohms 1% 1/8w
R443	0757-0438			R: fxd metflm 5.11k ohms 1% 1/8w
R444	0757-0844			R: fxd metflm 16.2k ohms 1% 1/2w
R445	0757-0401			R: fxd metflm 100 ohms 1% 1/8w
R446	0757-0274			R: fxd metflm 1.21k ohms 1% 1/8w
R447	0757-0288		3	R: fxd metflm 9.09k ohms 1% 1/8w
R448	0757-0465			R: fxd metflm 100k ohms 1% 1/8w
R449	0683-1005		1	R: fxd comp 10 ohms 5% 1/4w
R450	0757-0388		1	R: fxd metflm 30.1 ohms 1% 1/8w
R454	0757-0280			R: fxd metflm 1k ohm 1% 1/8w
R455	0757-0280			R: fxd metflm 1k ohm 1% 1/8w
R456	0757-0273			R: fxd metflm 3.01k ohms 1% 1/8w
R457	0757-0273			R: fxd metflm 3.01k ohms 1% 1/8w
R458	0757-0288			R: fxd metflm 9.09k ohms 1% 1/8w
R459	0757-0280			R: fxd metflm 1k ohm 1% 1/8w
R460	0757-0401			R: fxd metflm 100 ohms 1% 1/8w
R461	0757-0427			R: fxd metflm 1.5k ohms 1% 1/8w
R462	0757-0401			R: fxd metflm 100 ohms 1% 1/8w
R463	0757-0439			R: fxd metflm 6.81k ohms 1% 1/8w
R464	0757-0438			R: fxd metflm 5.11k ohms 1% 1/8w
R468	0757-0455		1	R: fxd metflm 36.5k ohms 1% 1/8w
R469	2100-0896		1	R: var ww 15k ohms 5% 1w
R470	0757-0451		1	R: fxd metflm 24.3k ohms 1% 1/8w
R471	2100-1443		1	R: var ww 50k ohms 3% 10 turn .1% lin 2w
R472	0757-0417			R: fxd metflm 562 ohms 1% 1/8w

Table 6-2. Replaceable Parts (Cont'd)

Ref Desig	hp Part No.	RS	TQ	Description (See Table 6-1.)
R473	2100-1772		1	R: var ww 500 ohms 10% 1/2w lin
R474	0757-0410		1	R: fxd metflm 301 ohms 1% 1/8w
R502	0698-3597		1	R: fxd metflm 15 megohms 1/2% 1/2w
R503	0698-5443		2	R: fxd metflm 9 megohms 1/2% 1/2w
R504	0698-5442		2	R: fxd metflm 6 megohms 1/2% 1/2w
R505	0698-5498		4	R: fxd metflm 1.5 megohms 0.1% 1/2w
R506	0698-5498			R: fxd metflm 1.5 megohms 0.1% 1/2w
R507	0698-5497		2	R: fxd metflm 600k ohms 0.1% 1/2w
R508	0698-5496		4	R: fxd metflm 255k ohms 0.1% 1/8w
R509	0698-5496			R: fxd metflm 255k ohms 0.1% 1/8w
R510	0698-5495		2	R: fxd metflm 102k ohms 0.1% 1/8w
R513	2100-1777		7	R: var ww 20k ohms 10% 1/2w lin
R514	2100-1777			R: var ww 20k ohms 10% 1/2w lin
R515	2100-1777			R: var ww 20k ohms 10% 1/2w lin
R516	2100-1777			R: var ww 20k ohms 10% 1/2w lin
R517	0757-0441		1	R: fxd metflm 8.25k ohms 1% 1/8w
R518	0757-0288			R: fxd metflm 9.09k ohms 1% 1/8w
R519	0757-0845			R: fxd metflm 18.2k ohms 1% 1/2w
R520	0698-5437		1	R: fxd metflm 12k ohms 1% 1/2w
R521	0757-0399		1	R: fxd metflm 82.5 ohms 1% 1/8w
R522	0757-0442			R: fxd metflm 10k ohms 1% 1/8w
R523	0757-0460		1	R: fxd metflm 61.9k ohms 1% 1/8w
R524	0757-0280			R: fxd metflm 1k ohm 1% 1/8w
R525	2100-2063			R: var comp 1k ohm 10% 1/2w
R526	0698-5443			R: fxd metflm 9 megohms 1/2% 1/2w
R527	0698-5442			R: fxd metflm 6 megohms 1/2% 1/2w
R528	0698-5498			R: fxd metflm 1.5 megohms 1/10% 1/2w
R529	0698-5498			R: fxd metflm 1.5 megohms 1/10% 1/2w
R530	0698-5497			R: fxd metflm 600k ohms 1/10% 1/2w
R531	0698-5496			R: fxd metflm 255k ohms 1/10% 1/8w
R532	0698-5496			R: fxd metflm 255k ohms 1/10% 1/8w
R533	0698-5495			R: fxd metflm 102k ohms 1/10% 1/8w
R537	2100-1777			R: var ww 20k ohms 10% 1/2w lin
R538	2100-1777			R: var ww 20k ohms 10% 1/2w lin
R539	2100-1777			R: var ww 20k ohms 10% 1/2w lin
R540	0757-0436			R: fxd metflm 4.32k ohms 1% 1/8w
R541	0757-0437		1	R: fxd metflm 4.75k ohms 1% 1/8w
R542	0757-0845			R: fxd metflm 18.2k ohms 1% 1/2w
S101	3100-1341		1	S: lever 4 position
S102	3100-1356		2	S: lever 4 position
S103	3100-1342		2	S: lever 2 position
S104	3100-1343		1	S: lever 3 position
S201	3101-0944		1	S: push button (includes DS201)
S301	3100-1347		1	S: lever 4 position
S302	3100-1356			S: lever 4 position
S303	3100-1342			S: lever 2 position

Table 6-2. Replaceable Parts (Cont'd)

Ref Desig	hp Part No.	RS	TQ	Description (See Table 6-1.)
S501				NSR: p/o A3
S502	3100-1349		1	S: sweep display
S503				NSR: p/o A3
TP101	5020-0495		10	TP: square pin
TP201	5020-0495			TP: square pin
TP202	5020-0495			TP: square pin
TP203	5020-0495			TP: square pin
TP204	5020-0495			TP: square pin
TP301	5020-0495			TP: square pin
TP401	5020-0495			TP: square pin
TP402	5020-0495			TP: square pin
TP403	5020-0495			TP: square pin
TP404	5020-0495			TP: square pin
V201	2140-0018		1	V: neon 1/10w
VR100	1902-0041		1	VR: breakdown 5.11v
VR101	1902-3150		2	VR: breakdown 9.1v
VR102	1902-0052		1	VR: breakdown 6.8v
VR201	1902-~~0214~~ 0688		2	VR: breakdown ~~56v~~ 53.6V
VR301	1902-3150			VR: breakdown 9.1v
VR401	1902-3288		2	VR: breakdown 30.9v
VR402	1902-3288			VR: breakdown 30.9v
VR403	1902-~~0214~~ 0688			VR: breakdown ~~56v~~ 53.6V
				MISCELLANEOUS
	0370-0341		1	Knob: black (Delayed time/div)
	0370-0342		1	Knob: black (Main time/div)
	0370-0432		7	Knob: black, lever
	0380-0022		2	Spacer: #5 x 3/8 (P1)
	0380-0059		4	Stand-off: 1/4"
	0380-0144		8	Stand-off: 3/16"
	0510-0942		2	Fastener: captive
	5020-0495		2	Pin: square
	1140-0036		1	Dial: 10 turn
	01801-01206		4	Bracket angle
	01821-00203		1	Panel: rear
	01821-00212		1	Panel: front
	01821-01201		1	Bracket: (A1)
	01821-01204		1	Bracket: plug (J1)
	01821-01205		1	Bracket: sweep dial
	01821-04001		1	Dial: sweep
	01821-04101		1	Plate: mounting (P2)
	01821-04701		1	Support: right plug-in
	01821-21701		1	Bushing: push button
	01821-21702		1	Bushing: R525
	01821-25701		1	Nut: bushing

Table 6-2. Replaceable Parts (Cont'd)

Ref Desig	hp Part No.	RS	TQ	Description (See Table 6-1.)
	01821-60101		1	Chassis: right
				Consists of:
	5000-0470		1	Bar: locking
	5020-0496		2	Guide: locking bar
	5020-0497		2	Button: locking bar
	5040-0456		1	Latch: release
	5040-0457		1	Latch: plug-in
	01821-43101		1	Guide: plug-in lock
	01821-60203		1	Panel: sub
	01821-61627		1	Cable: #1
				Consists of:
	01821-61612		1	Coax: (Q402 to CR410)
	01821-61613		1	Coax: (Q410 to C414)
	01821-61619		1	Coax: (Q402 to P1 pin 13)
	01821-61626		1	Coax: (R214/R216 to DS201)
	01821-61624		1	Cable: #2
				Consists of:
	01821-61604		1	Coax: (P1 pin 16 & 32 to J1 pin 1 & 13)
	01821-61605		1	Coax: (R455 to J401)
	01821-61606		1	Coax: (P1 pin 6 to J1 pin 24)
	01821-61607		1	Coax: (J1 pin 16 to P1 pin 18)
	01821-61610		1	Coax: (J1 pin 14 to Q102)
	01821-61611		1	Coax: (R102 to S101)
	01821-61616		1	Coax: (R471 to Q412)
	01821-61617		1	Coax: (R434 to P1 pin 12)
	01821-61618		1	Coax: (R434 to S502)
	01821-61603		1	Cable: #3
				Consists of:
	01821-61614		1	Coax: (S502 to R520)
	01821-61615		1	Coax: (R411 to S502)
	01821-61620		1	Coax: (R250 to P1 pin 11)
	01821-61621		1	Coax: (S502 to P1 pin 1)
	01821-61622		1	Coax: (Q202 to P1 pin 14)
	01821-61608		1	Cable: delayed sweep switch
	01821-61609		1	Cable: main sweep switch
	01821-61623		1	Coax: (R250 to S502)
	01821-67401		2	Knob: level
	01821-67402		1	Knob: sweep display
	01821-67403		2	Knob: Vernier

SECTION VII

MANUAL CHANGES AND OPTIONS

7-1. MANUAL CHANGES.

7-2. This manual applies directly to the Model 1821A Time Base and Delay Generator (as manufactured) with serials prefixed 809-. The following paragraphs explain how to adapt this manual to apply to newer instruments (higher serial prefix) or older instruments (lower serial prefix). Technical corrections to this manual (if any) are called errata and are listed on a separate "Manual Changes" sheet supplied with this manual.

7-3. NEWER INSTRUMENTS. If the serial prefix of your Model 1821A is above 809-, refer to a separate "Manual Changes" sheet supplied with this manual. Locate the serial prefix of your instrument and make the indicated changes.

7-4. OLDER INSTRUMENTS. If the serial prefix of your Model 1821A is below 809-, operating, service and adjustment information is contained in a previous edition of this manual. Contact your nearest HP Sales/Service Office to obtain data applicable to your instrument, and be sure to refer to the serial prefix of your instrument.

7-5. OPTIONS.

7-6. Options are standard modifications performed on hp instruments at the factory. No options for the Model 1821A are offered at the present time.

7-7. SPECIAL INSTRUMENTS.

7-8. Special instruments are standard hp instruments that are modified at the factory according to customer specifications. These instruments are identified by a tag adjacent to the serial number tag. A separate insert sheet is included in the manual for each special instrument that has been modified in a manner that effects the replaceable parts list. Change the manual according to the insert sheet for proper instrument coverage.

SECTION VIII
SCHEMATICS AND TROUBLESHOOTING

8-1. INTRODUCTION.

8-2. This section contains schematic diagrams, component identificatoin, and troubleshooting and repair information for the Model 1821A. Performance Check and Adjustment procedures are provided in Section V.

8-3. SCHEMATIC DIAGRAMS.

8-4. Schematic diagrams appear on right-hand pages that unfold outside the right edge of the manual. These "throw-clear" pages allow viewing the schematics while referring to other sections in the manual.

8-5. Schematics are primarily drawn to show circuit function. A given schematic may include all or part of several assemblies. Table 8-1 provides information about symbols and conventions used in the schematics. DC voltages and waveform test points are provided on the schematics. DC voltage measurement conditions, waveform measurement conditions, and waveforms applicable to each schematic are shown adjacent to that schematic.

8-6. COMPONENT IDENTIFICATION.

8-7. Whenever possible, the location of components appearing on a schematic is shown on the page opposite that schematic. When components on an assembly appear on more than one schematic, the location of all components on that assembly are identified opposite the first schematic showing that assembly. Adjustments, assemblies, and chassis mounted components are identified in Figure 8-2.

8-8. TROUBLESHOOTING.

8-9. The first and most important prerequisite for successful troubleshooting is a thorough understanding of instrument operation and function. Often, suspected malfunctions are caused by improper control settings such as: intensity set too low, display selector or mode switch in wrong position, trigger level maladjusted, etc. Read Section III, Operation, and Section IV, Principles of Operation, for this information.

8-10. DC voltages for most active components (transistors, FET's, etc.) are indicated on the schematics. Waveform test points are also shown on the schematic at various points along the main signal path. The numbers inside the test point symbols are keyed to the proper waveform adjacent to the schematic. These voltages and waveforms are invaluable for troubleshooting the instrument. Applications include: checking stage gain, locating unbalance in differential amplifiers, locating faulty transistors, etc. Always refer to the specific measurement conditions before using dc voltages or waveforms. Allow the level to stabilize before ntoing dc voltages. Small dots are etched on circuit board assemblies next to the emitter lead of transistors, the source lead of FET's, the cathode side of diodes, and the positive side of electrolytic capacitors as an aid to locating test points.

CAUTION

When taking waveform or dc measurements, use extreme care to avoid shorting supply voltages or components.

8-11. If a malfunction occurs, Figure 8-1 may help isolate the trouble to a particular circuit. Always begin troubleshooting with a visual inspection. Check for burned or loose components, loose wire connections, faulty switch contacts or any similar conditions suggesting a source of trouble.

8-12. REPAIR AND REPLACEMENT.

8-13. Almost all electrical components are accessible for replacement from the component side of the etched circuit board. Small dots are etched on circuit board assemblies next to the emitter lead of transistors, the source lead of FET's, the cathode side of diodes, and the positive side of electrolytic capacitors as an aid when replacing components. Section VI provides a detailed parts list to allow ordering replacement parts. Mechanical and miscellaneous electrical parts are listed at the end of Table 6-2. If satisfactory operation or repair cannot be accomplished, contact the nearest Hewlett-Packard Sales/Service Office (addresses at rear of this manual). If shipment for repair is required, see Section II for recommended packaging procedure.

8-14. Etched circuit boards in this instrument have components mounted on one side of the board, conductive surfaces on both sides, and plated-through component mounting holes. Hewlett-Packard Service Note M-20E contains useful information on servicing etched circuit boards. Important considerations are as follows:

a. Use low heat (37 to 47.5 watts, less than 800°F idling temperature), slightly bent chisel tip (1/16 to 1/8 inch diameter) soldering iron; and a small diameter high tin content solder. If a rosin solder is used, clean the area thoroughly after soldering.

b. Components may be removed by placing the soldering iron on the component lead from either side of the board, and pulling up on the lead. If heat is applied to the component side of the board, greater care is required to avoid damaging the component (especially true for semiconductors). If heat damage is likely to occur, grip the lead with a pair of pliers to provide a heat sink between the soldering iron and component.

c. If a component is obviously damaged or faulty, clip the leads close to the component and then unsolder the leads from the board.

d. Large components such as potentiometers may be removed by rotating the soldering iron from lead to lead and applying steady pressure to lift the part free (the alternative is to clip the leads of a damaged part).

e. Since the conductor portion of the etched circuit board is a metal plated surface covered with solder, use care to avoid overheating which causes the conductor to lift away from the board. A lifted conductor may be cemented back in place with a quick-drying acetate base cement (use sparingly) having good insulating properties. Another method of repair is to solder a section of copper wire along the damaged area.

f. Clear the solder from the component hole before inserting a new component lead. Heat the solder in the hole, remove the iron, and quickly insert a pointed non-metallic object, such as a toothpick.

g. Shape the new component leads and clip to proper length. Insert the leads into the holes, apply heat and solder (preferably on the side opposite the component).

Table 8-1. Schematic Diagram Notes

Refer to MIL-STD-15-1A for schematic symbols not listed in this table.

= Etched circuit board

= Front panel marking

= Rear panel marking

= Front panel control

= Screwdriver adjustment

P/O = Part of

CW = Clockwise end of variable resistor

N.C. = No connection

= Waveform test point (with number)

= Common electrical point (with letter) not necessarily ground

= Single pin connector

= Pin of a plug-in board (with letter or number)

= Primary signal flow

= Secondary signal flow

* = Optimum value selected at factory, average value shown; part may have been omitted.

= Field effect transistor (N-channel)

= Breakdown diode

= Tunnel diode

= Step recovery diode

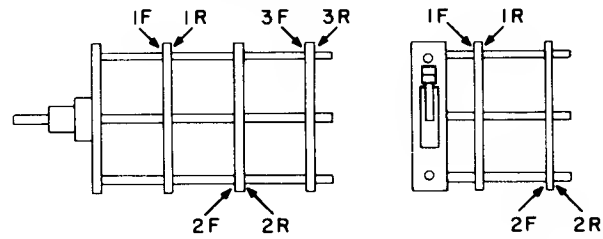
= Circuits or components drawn with dashed lines (phantom) show function only and are not intended to be complete. The circuit or component is shown in detail on another schematic.

Unless otherwise indicated:
resistance in ohms
capacitance in picofarads
inductance in microhenries

Wire colors are given by numbers in parentheses using the resistor color code [(925) is wht-red-grn].

0 - Black	5 - Green
1 - Brown	6 - Blue
2 - Red	7 - Violet
3 - Orange	8 - Gray
4 - Yellow	9 - White

Switch wafers are identified as follows:



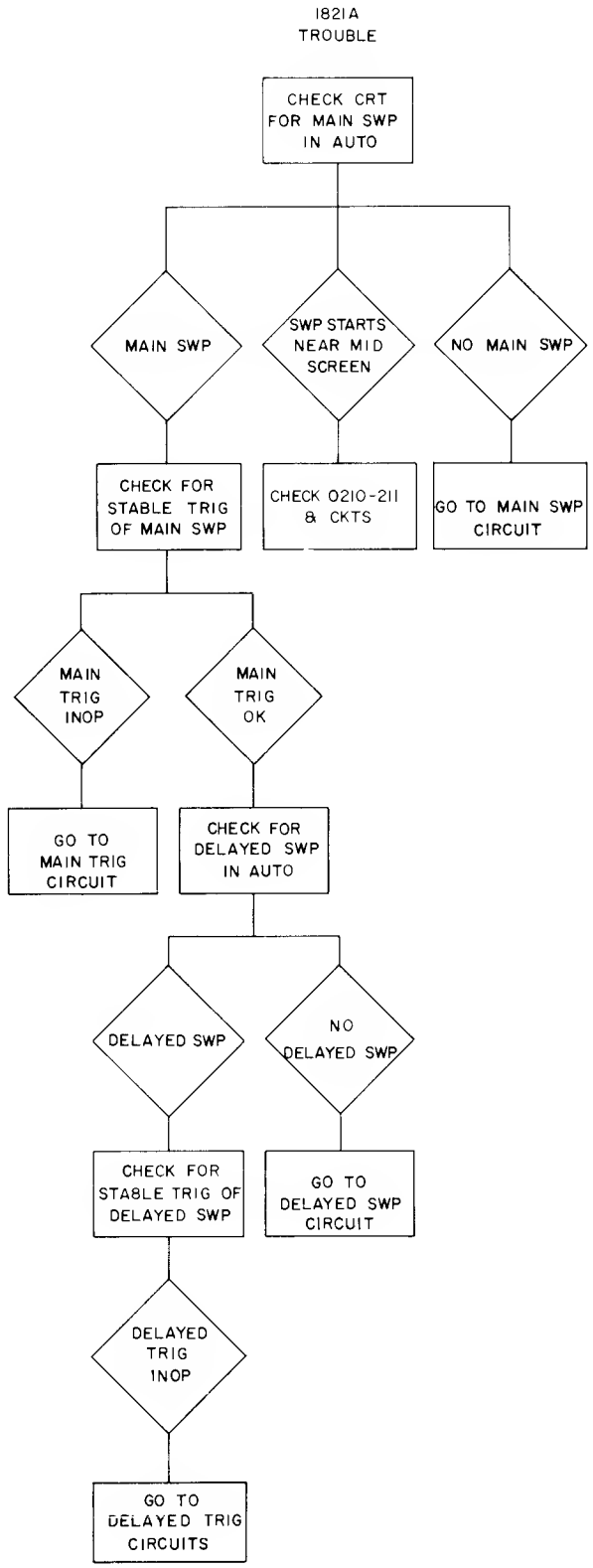


Figure 8-1. Over-all Troubleshooting Tree

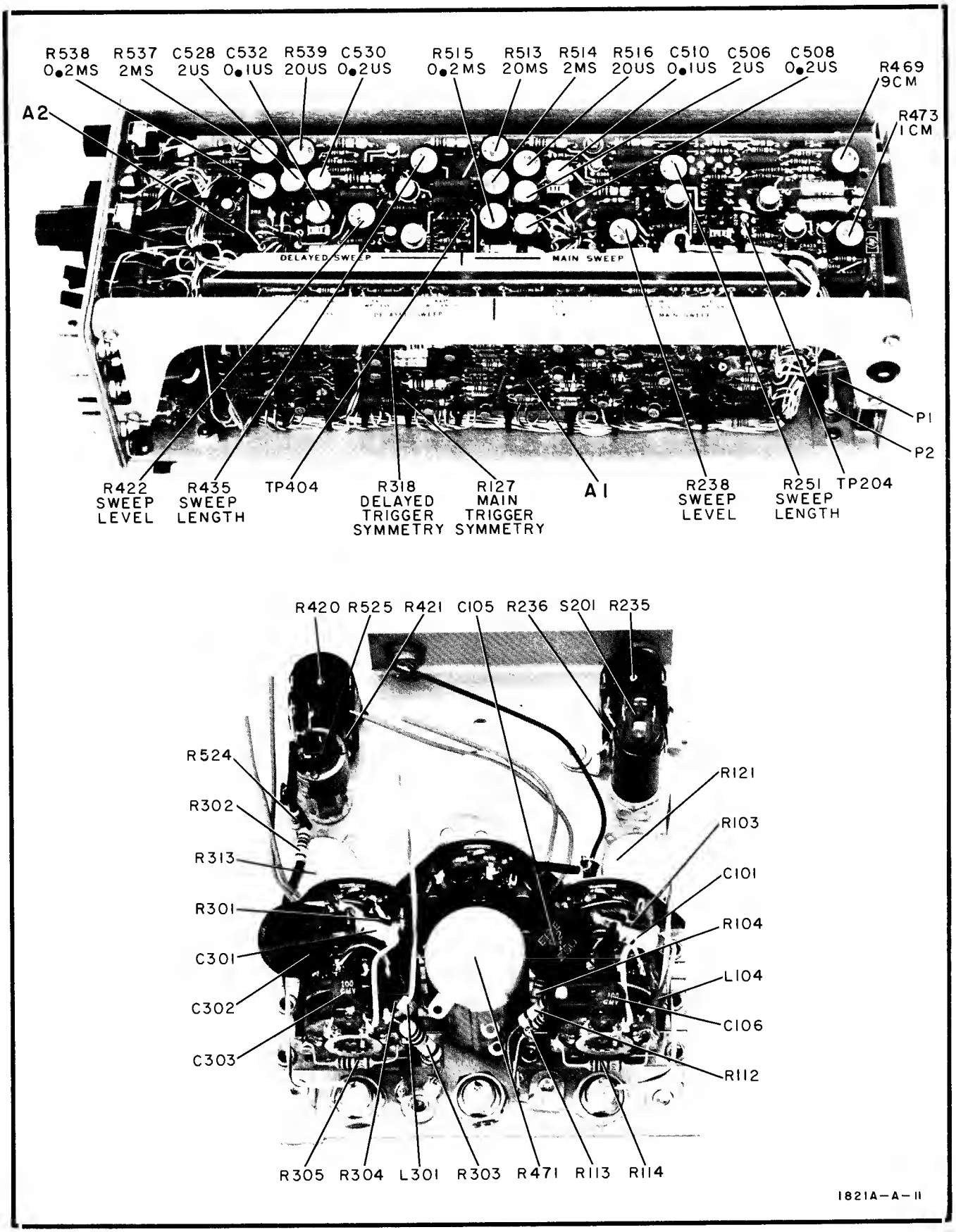
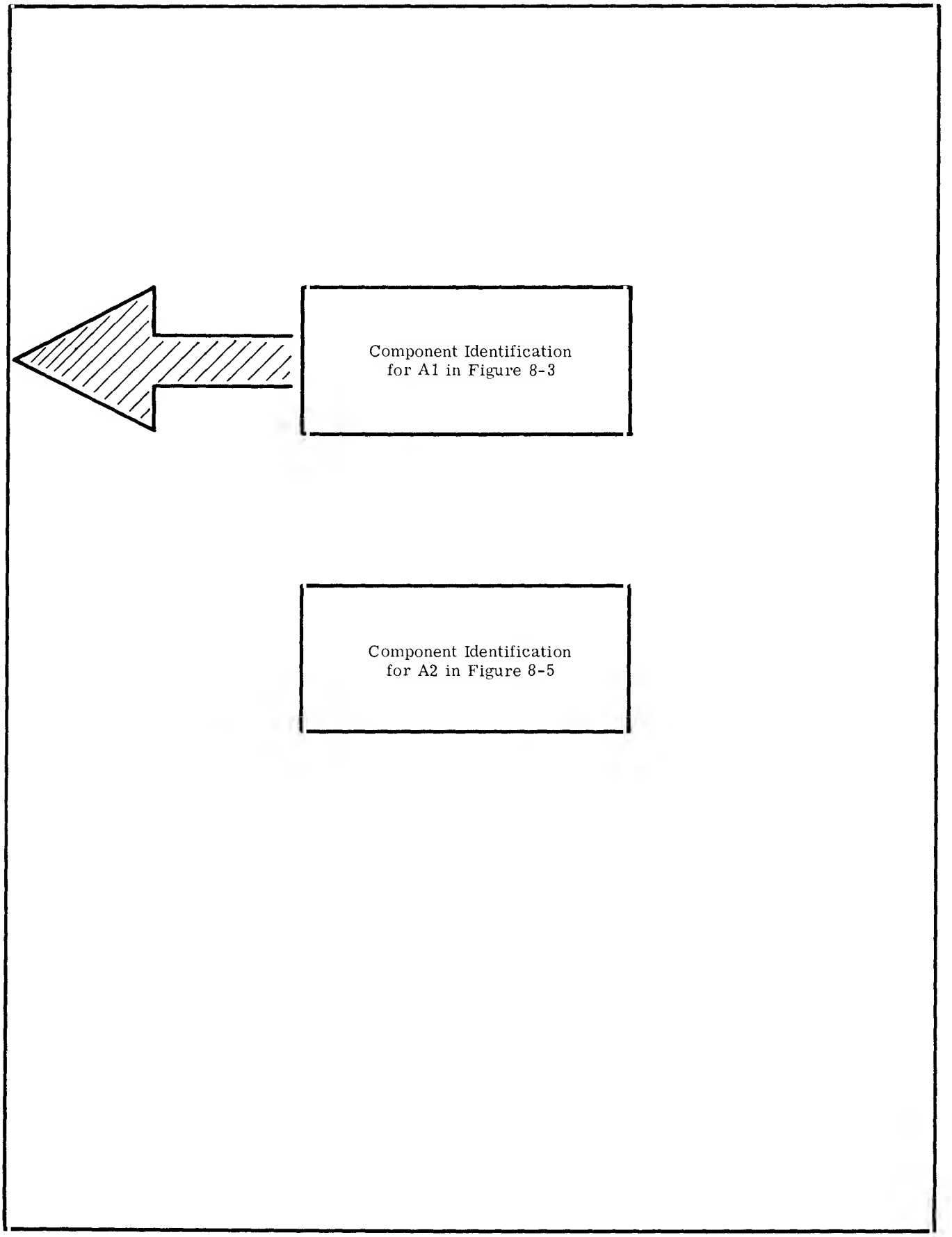
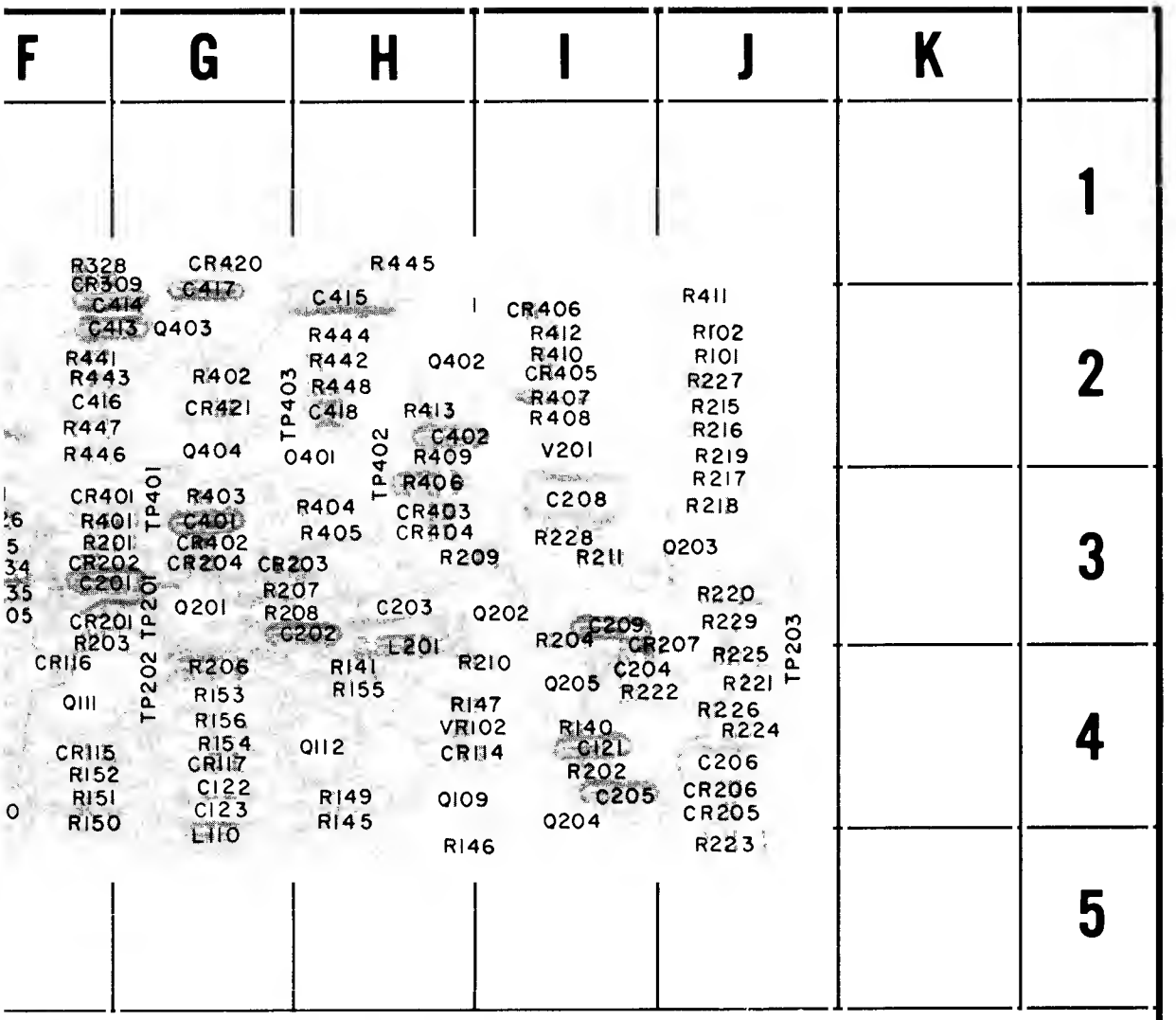


Figure 8-2. Adjustment Location and Component Identification.

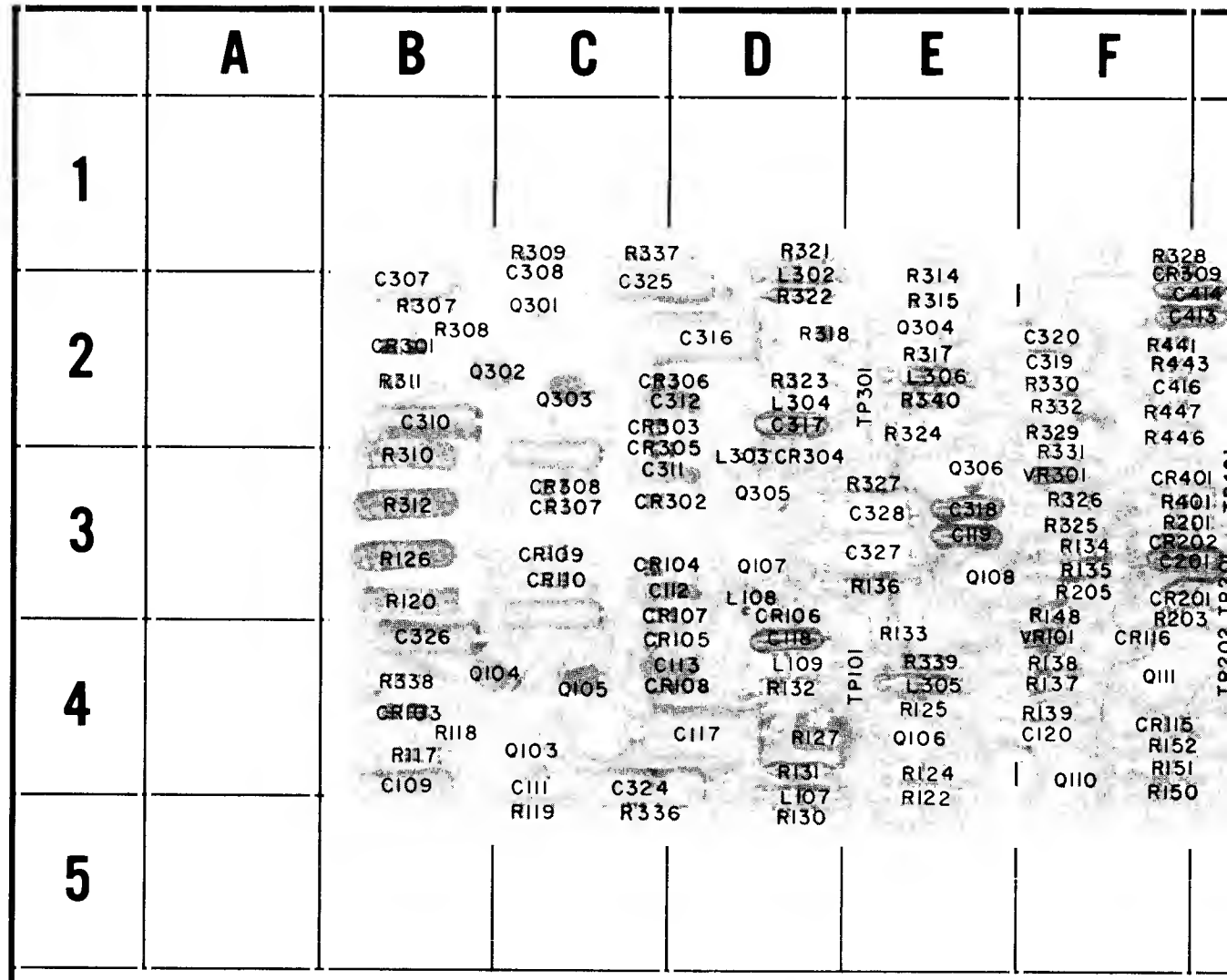

Component Identification
for A1 in Figure 8-3
Component Identification
for A2 in Figure 8-5



REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
R117	B-4	R147	H-4	R217	J-3	R321	D-1	R409	H-2
R118	B-4	R148	F-3	R218	J-3	R322	D-2	R410	I-2
R119	C-5	R149	H-4	R219	J-2	R323	D-3	R411	J-2
R120	B-3	R150	F-4	R220	J-3	R324	E-2	R412	I-2
R122	E-5	R151	F-4	R221	J-4	R325	F-3	R413	H-2
R124	E-4	R152	F-4	R222	I-4	R326	F-3	R441	F-2
R125	E-4	R153	G-4	R223	J-5	R327	E-3	R442	H-2
R126	B-3	R154	G-4	R224	J-4	R328	F-1	R443	F-2
R127	D-4	R155	H-4	R225	J-4	R329	F-2	R444	H-2
R130	D-5	R156	G-4	R226	J-4	R330	F-2	R445	H-1
R131	D-4	R201	F-3	R227	J-2	R331	F-3	R446	F-2
R132	D-4	R202	I-4	R228	I-3	R332	F-2	R447	F-2
R133	E-4	R203	F-3	R229	J-3	R336	C-5	R448	H-2
R134	F-3	R204	I-3	R307	B-2	R337	C-1	TP101	E-4
R135	F-3	R205	F-3	R308	B-2	R338	B-4	TP201	G-3
R136	E-3	R206	G-4	R309	C-1	R339	E-4	TP202	G-4
R137	F-4	R207	G-3	R310	B-3	R340	E-2	TP203	J-4
R138	F-4	R208	G-3	R311	B-2	R401	F-3	TP301	E-2
R139	F-4	R209	H-3	R312	B-3	R402	G-2	TP401	G-3
R140	I-4	R210	I-4	R314	E-2	R403	G-3	TP402	H-3
R141	H-4	R211	I-3	R315	E-2	R404	H-3	TP403	G-2
R145	H-4	R215	J-2	R317	E-2	R405	H-3	V201	I-2
R146	H-5	R216	J-2	R318	D-2	R406	H-3	VR101	F-4
						R407	I-2	VR102	H-4
						R408	I-2	VR301	F-3

1821A-B-2B

ponent Identification, A1



REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
C109	B-4	C312	C-2	CR107	C-3	CR309	F-1	Q107	D-3	R117	B-4
C111	C-4	C316	D-2	CR108	C-4	CR401	F-3	Q108	E-3	R118	B-4
C112	C-3	C317	D-2	CR109	C-3	CR402	G-3	Q109	H-4	R119	C-5
C113	C-4	C318	E-3	CR110	C-3	CR403	H-3	Q110	F-4	R120	B-3
C117	D-4	C319	F-2	CR114	H-4	CR404	H-3	Q111	F-4	R122	E-5
C118	D-4	C320	F-2	CR115	F-4	CR405	I-2	Q112	H-4	R124	E-4
C119	E-3	C324	C-4	CR116	F-4	CR406	I-2	Q201	G-3	R125	E-4
C120	F-4	C325	C-2	CR117	G-4	CR420	G-1	Q202	I-3	R126	B-3
C121	I-4	C326	B-4	CR201	F-3	CR421	G-2	Q203	J-3	R127	D-4
C122	G-4	C327	E-3	CR202	F-3	L107	D-5	Q204	I-4	R130	D-5
C123	G-4	C328	E-3	CR203	G-3	L108	D-3	Q205	I-4	R131	D-4
C201	I-3	C401	G-3	CR204	G-3	L109	D-4	Q301	C-2	R132	D-4
C202	H-3	C402	H-2	CR205	J-4	L110	G-5	Q302	B-2	R133	E-4
C203	H-3	C413	F-2	CR206	J-4	L201	H-3	Q303	C-2	R134	F-3
C204	I-4	C414	F-2	CR207	I-3	L302	D-1	Q304	E-2	R135	F-3
C205	I-4	C415	H-2	CR301	B-2	L303	D-3	Q305	D-3	R136	E-3
C206	J-4	C416	F-2	CR302	C-3	L304	D-2	Q306	E-3	R137	F-4
C208	I-3	C417	G-2	CR303	C-2	L305	E-4	Q401	H-2	R138	F-4
C209	I-3	C418	H-2	CR304	D-3	L306	E-2	Q402	H-2	R139	F-4
C307	B-2	CR103	B-4	CR305	C-3	Q103	C-4	Q403	G-2	R140	I-4
C308	C-1	CR104	C-3	CR306	C-2	Q104	B-4	Q404	G-2	R141	H-4
C310	B-2	CR105	C-4	CR307	C-3	Q105	C-4	R101	J-2	R145	H-4
C311	C-3	CR106	D-3	CR308	C-3	Q106	E-4	R102	J-2	R146	H-5

Figure 8-3. Component Identifi

DC VOLTAGE MEASUREMENT CONDITIONS

1. Initial Control Settings:

   Horizontal DISPLAY · · · · · · · · · · · · INT
   SWEEP MODE · · · · · · · · · · · · · · · AUTO
   Main TRIGGER LEVEL · · · · · · · · · fully cw
   Main Trigger Source · · · · · · · · · EXT÷10
   Main SLOPE · · · · · · · · · · · · + (positive)
   Main Trigger Coupling · · · · · · · · · · · DC

   Adjust Vertical Position control for 0 vdc at junction of R108 and R109.

2. All voltages not in parenthesis are measured after making initial control settings.

3. All voltages within parenthesis are measured after making initial control settings with the following differences:

   Main TRIGGER LEVEL · · · · · · · · fully ccw
   SWEEP MODE · · · · · · · · · · · · · SINGLE

4. All voltages are referenced to chassis ground.

WAVEFORM MEASUREMENT CONDITIONS

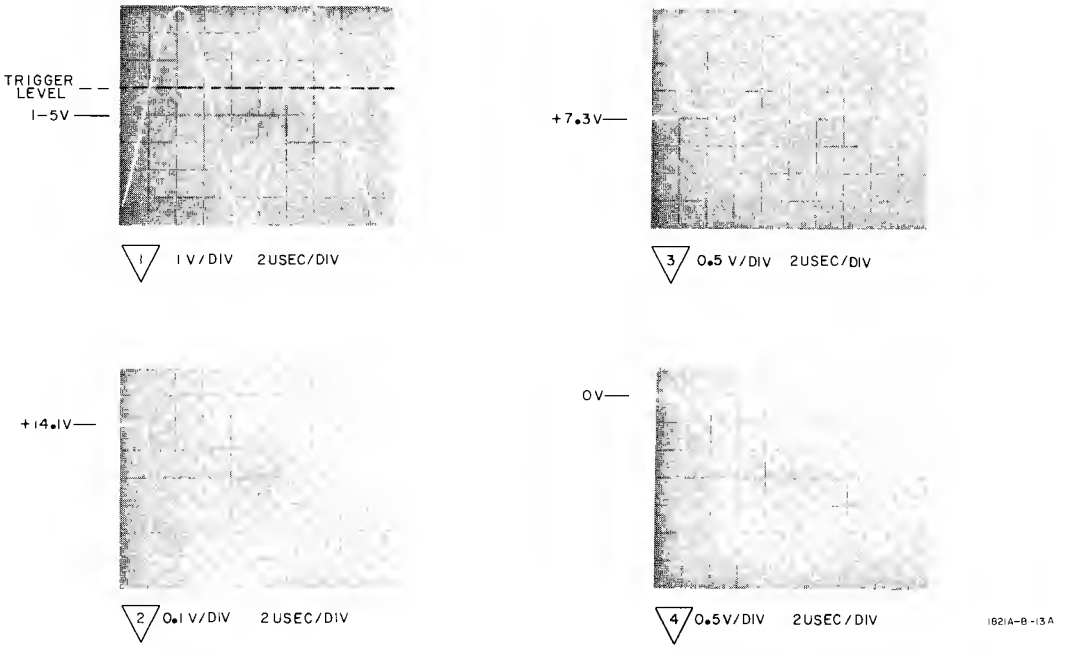
1. Initial Control Settings:

   Horizontal DISPLAY · · · · · · · · · · · · INT
   SWEEP MODE · · · · · · · · · · · · · · · NORM
   Main TRIGGER LEVEL · · · · · · · · · · · · 0
   Main Trigger Source · · · · · · · · · · · · EXT
   Main SLOPE · · · · · · · · · · · · · + (positive)
   Main Trigger Coupling · · · · · · · · · · · · AC

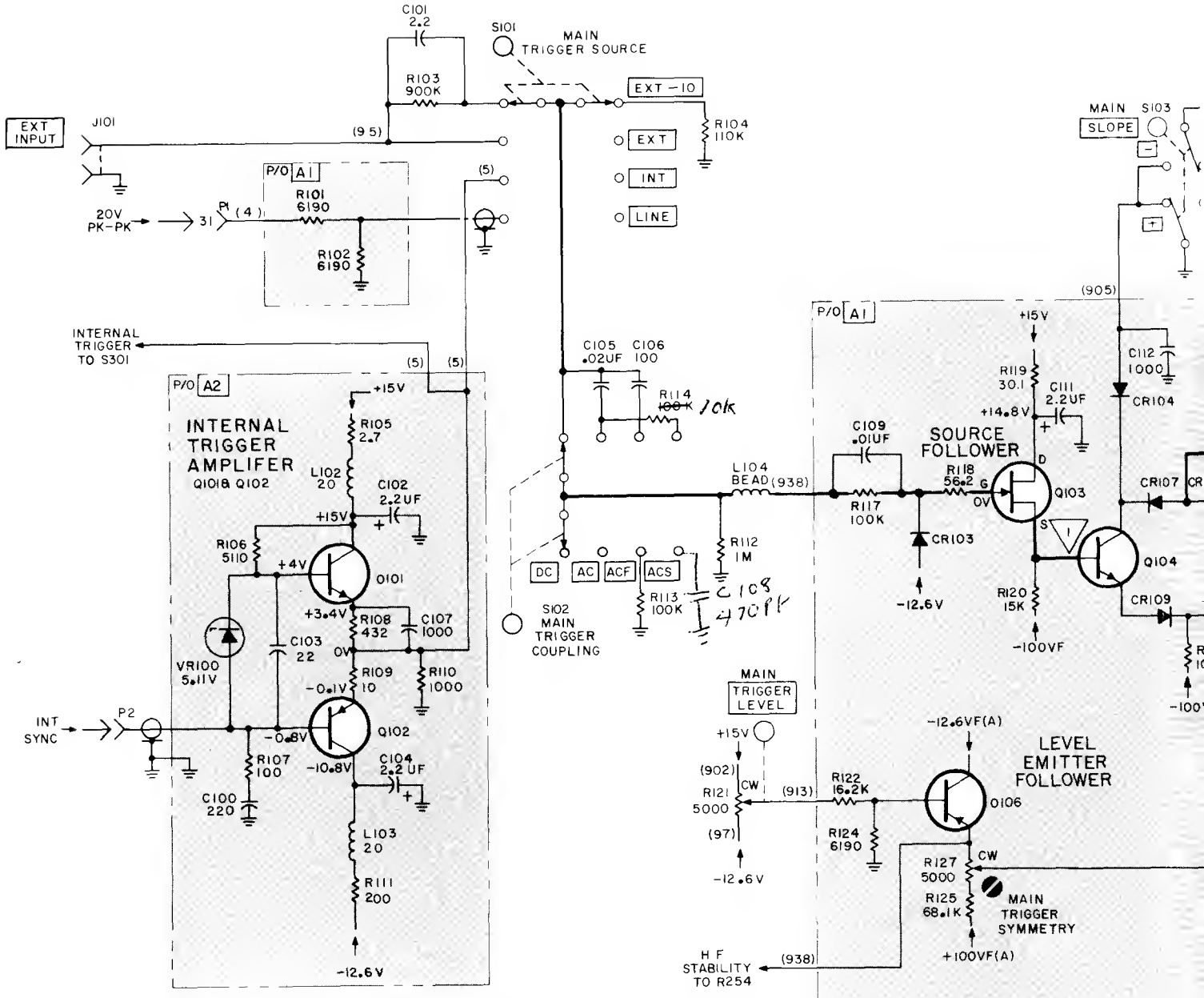
2. Connect a 100 kHz 8 v pk-pk sine wave to Main EXT INPUT.

3. Adjust Main TRIGGER LEVEL to obtain waveform number 2.

4. All waveforms are referenced to chassis ground.



Waveforms and Measurement Conditions



REFERENCE DESIGNATIONS

P/O A1, P/O A2
C100-107,109,111-113,117-123
CR103-110, 114-117
J101
L102-104,107-110
P/O P1, P2
Q101-112
R101-114, 117-122,124-127,130-141, 145-156
S101-104
TP101
VR100-102

DELETED: C110, CR101, CR102, L106, R123

SEE TABLE 8-1 FOR SYMBOLS AND CONVENTIONS

1621A-MAIN TRIG 809-

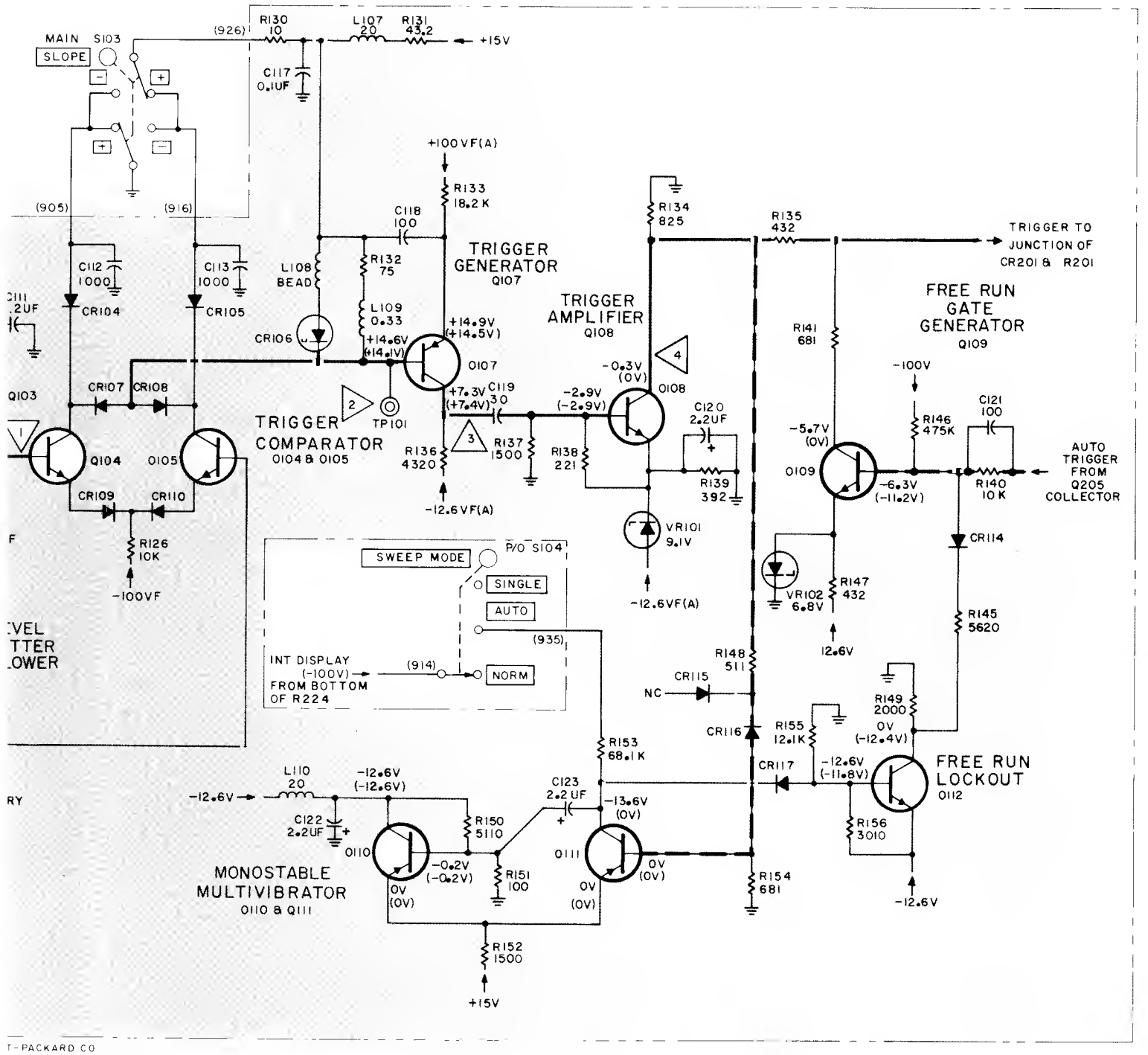
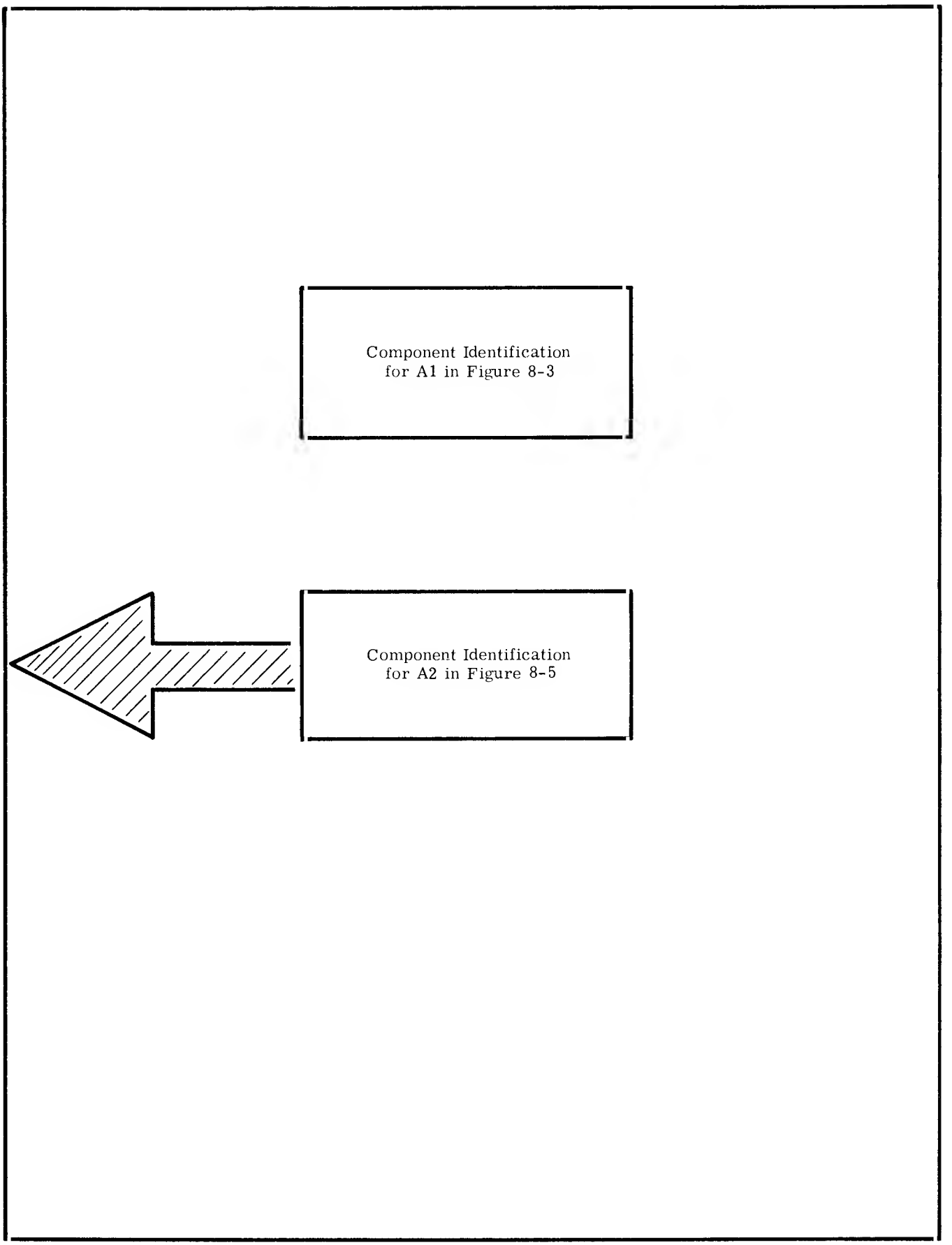
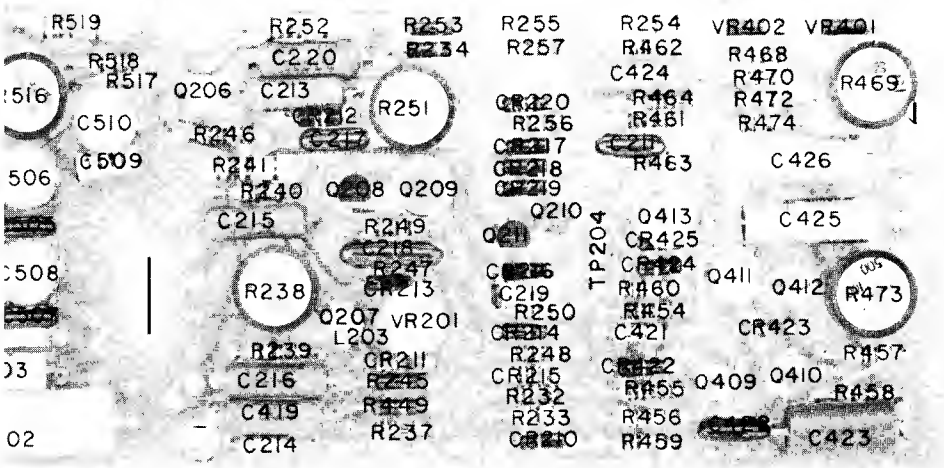


Figure 8-4. Main Trigger Schematic Diagram


Component Identification
for A1 in Figure 8-3
Component Identification
for A2 in Figure 8-5



GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
G-3	Q412	J-3	R245	H-3	R423	C-3	R457	J-3	R516	F-2
D-3	Q413	I-2	R246	G-2	R424	C-2	R458	J-3	R517	F-2
B-2	R105	B-2	R247	H-3	R425	C-2	R459	I-4	R518	F-2
A-2	R106	B-2	R248	H-3	R429	E-3	R460	I-3	R519	F-1
G-2	R107	A-3	R249	H-2	R430	C-2	R461	I-2	R537	B-2
G-3	R108	A-3	R250	H-3	R431	E-3	R462	I-2	R538	B-2
G-2	R109	B-3	R251	H-2	R432	D-3	R463	I-2	R539	C-2
H-2	R110	B-3	R252	G-1	R433	D-2	R464	I-2	R540	C-2
I-2	R111	B-3	R253	H-1	R434	E-3	R468	J-2	R541	C-2
H-2	R232	H-3	R254	I-1	R435	D-2	R469	J-2	R542	C-1
D-2	R233	H-3	R255	H-1	R436	E-1	R470	J-2	TP204	I-3
D-3	R234	H-1	R256	H-2	R437	E-2	R472	J-2	TP404	E-3
D-2	R237	H-4	R257	H-1	R449	H-3	R473	J-3	VR100	B-2
D-2	R238	G-3	R417	D-3	R450	E-3	R474	J-2	VR201	H-3
I-3	R239	G-3	R418	D-3	R454	I-3	R513	E-2	VR401	J-1
J-3	R240	G-2	R419	E-3	R455	I-3	R514	E-2	VR402	J-1
I-3	R241	G-2	R422	C-3	R456	I-3	R515	E-3	VR403	D-3

1821A — B — 3A

Identification, A2

DC VOLTAGE MEASUREMENT CONDITIONS

1. Initial Control Settings:

Horizontal DISPLAY	INT
Main VERNIER	CAL
Sweep Display	MAIN
Main TIME/DIV	1 µSEC
SWEEP MODE	NORM

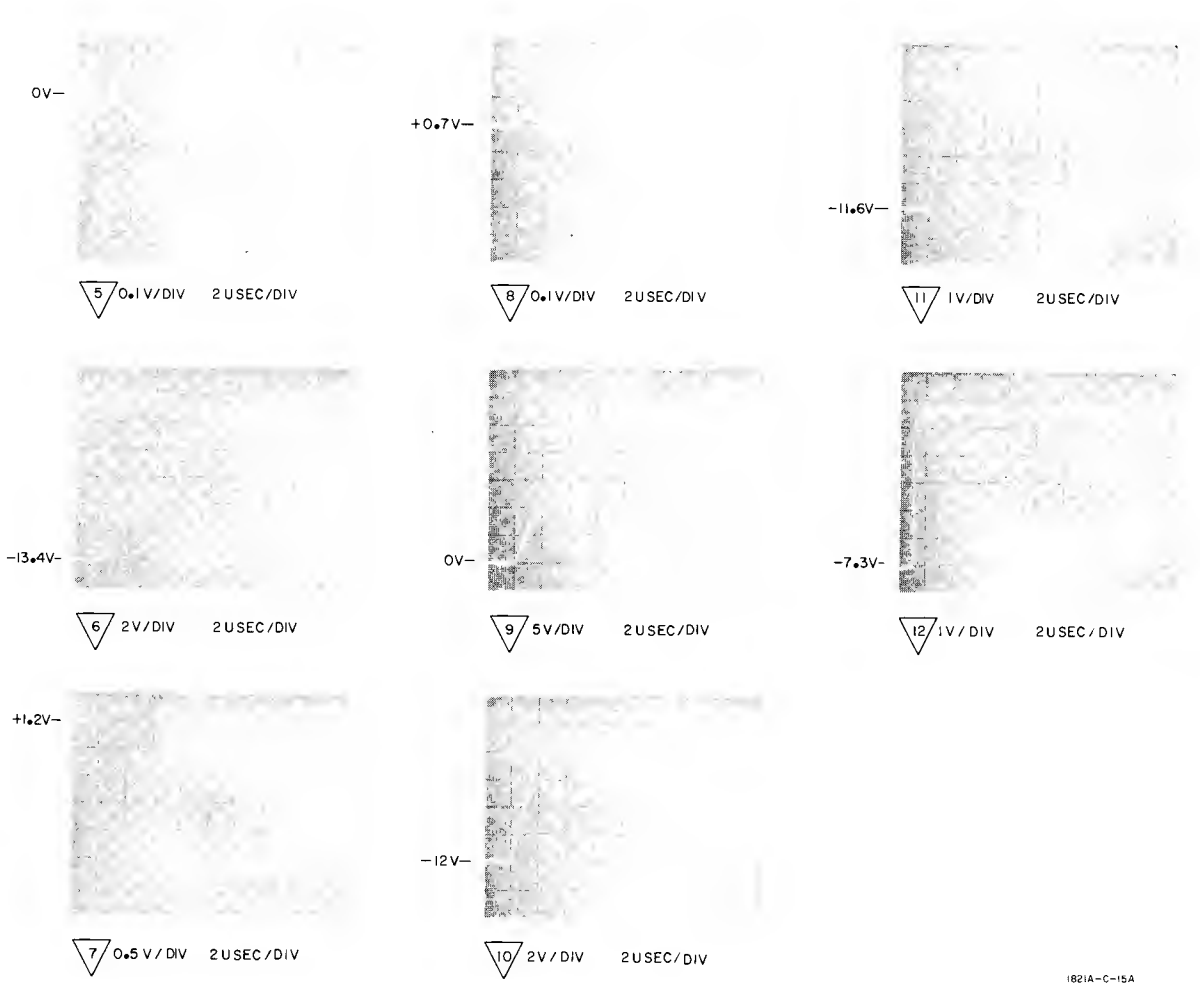
2. All voltages not in parenthesis are measured after making initial control settings.
3. All voltages within parenthesis are measured after making initial control settings and connecting TP201 through a 1k ohm resistor to -12.6 v.
4. All voltages are referenced to chassis ground.

WAVEFORM MEASUREMENT CONDITIONS

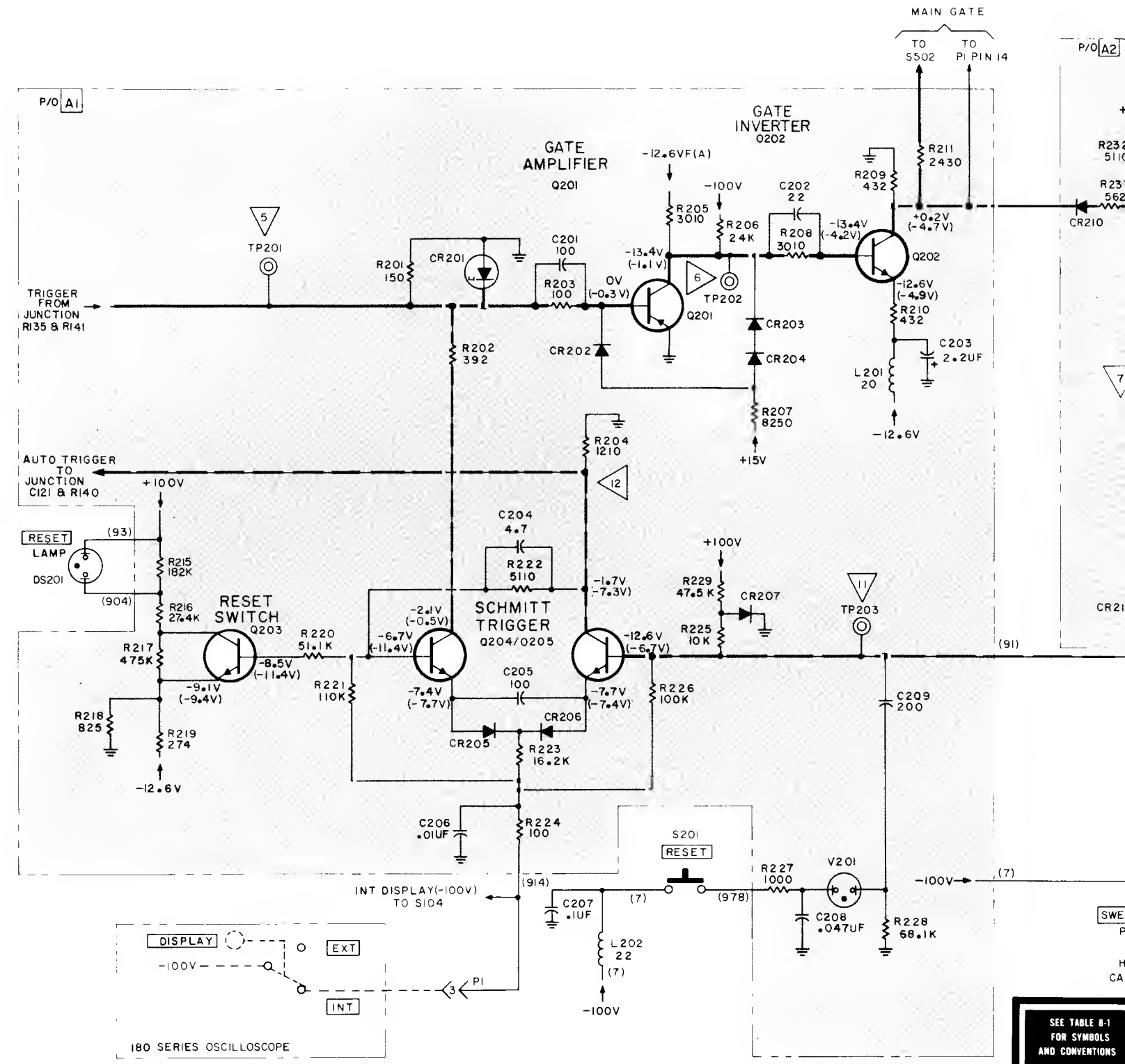
1. Initial Control Settings:

Horizontal DISPLAY	INT
Sweep Display	MAIN
Main TIME/DIV	0.5 µSEC
SWEEP MODE	NORM
Main VERNIER	CAL
Main TRIGGER LEVEL	0
Main Trigger Source	EXT

2. Connect a 100 kHz 8 v pk-pk sine wave to Main EXT INPUT.
3. All waveforms are referenced to chassis ground.



Waveforms and Measurement Conditions


MAIN GATE
TO S502
TO P1 PIN 14
P/O A1
P/O A2
GATE AMPLIFIER
Q201
GATE INVERTER
0202
-12.6VF(A)
-100V
R205 3010
R206 24K
C202 22
R208 3010
R209 432
R211 2430
+0.2V (-4.7V)
CR210
TP201
R201 150
CR201
C201 100
R203 100
-13.4V (-1.1V)
OV (-0.3V)
TP202
Q202
-13.4V (-4.2V)
-12.6V (-4.9V)
R210 432
C203 2.2UF
L201 20
-12.6V
TRIGGER FROM JUNCTION R135 & R141
R202 392
CR202
CR203
CR204
R207 8250
+15V
R204 1210
AUTO TRIGGER TO JUNCTION C121 & R140
+100V
RESET LAMP
DS201
(93)
(904)
R215 182K
R216 27.4K
RESET SWITCH
Q203
R217 475K
R218 825
R219 274
-12.6V
R220 51.1K
-8.5V (-11.4V)
-9.1V (-9.4V)
C204 4.7
R222 5110
-1.7V (-7.3V)
SCHMITT TRIGGER
Q204/0205
-2.1V (-0.5V)
-6.7V (-11.4V)
-7.4V (-7.7V)
-12.6V (-6.7V)
-7.7V (-7.4V)
C205 100
R221 110K
R226 100K
CR205
CR206
R223 16.2K
C206 .01UF
R224 100
+100V
R229 47.5K
CR207
R225 10K
TP203
(91)
C209 200
S201
RESET
R227 1000
V201
-100V
(7)
(914)
INT DISPLAY(-100V) TO S104
C207 .1UF
(978)
C208 .047UF
R228 68.1K
L202 22
(7)
-100V
DISPLAY
EXT
-100V
INT
P1
180 SERIES OSCILLOSCOPE
SEE TABLE 8-1 FOR SYMBOLS AND CONVENTIONS

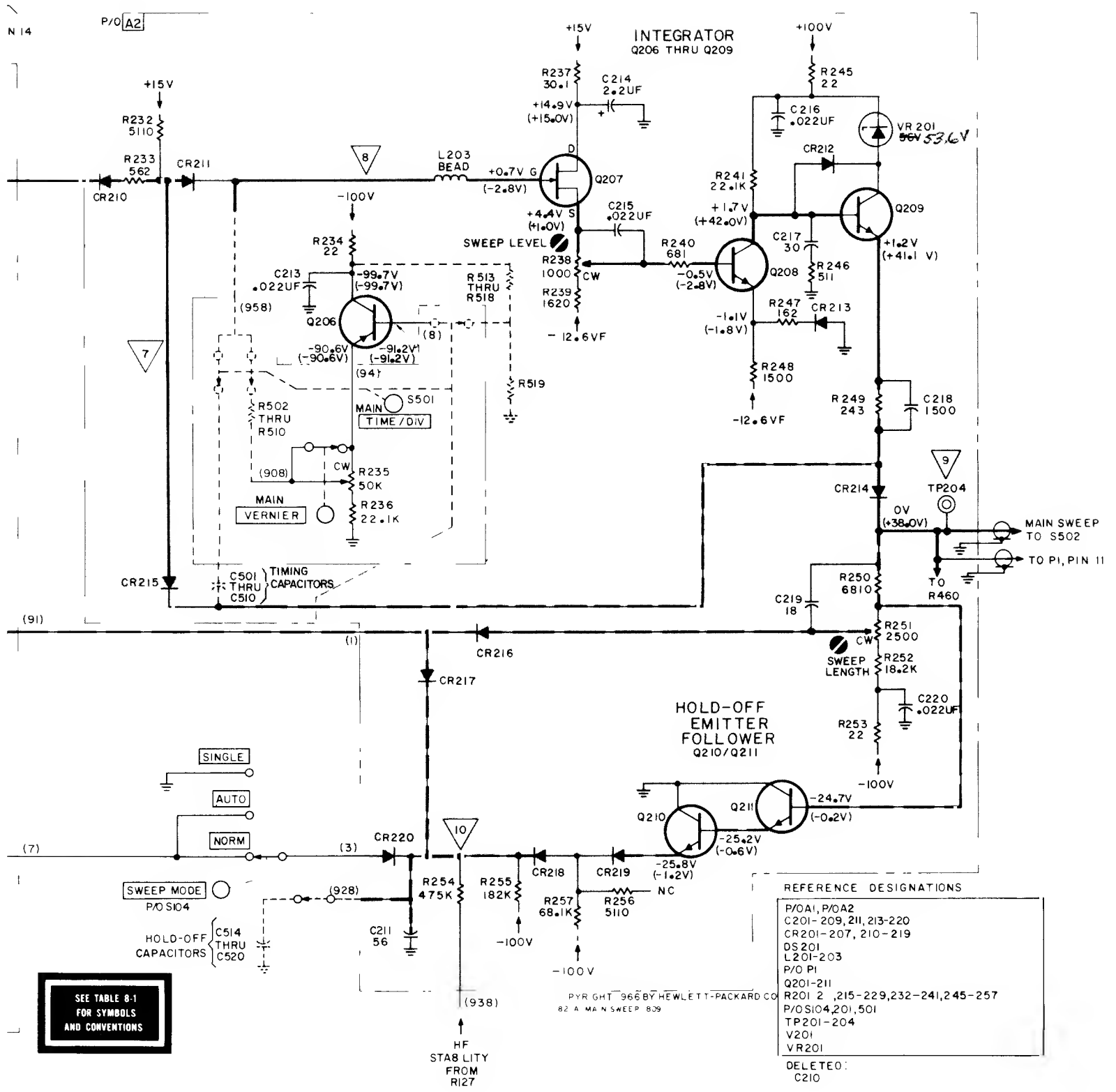


Figure 8-6. Main Sweep Schematic Diagram

Component Identification
for A1 in Figure 8-3

DC VOLTAGE MEASUREMENT CONDITIONS

1. Control Settings:

Horizontal DISPLAY	INT
Delayed TRIGGER LEVEL	fully ccw
Delayed Trigger Source	EXT÷10
Delayed SLOPE	+ (positive)
Delayed Trigger Coupling	DC

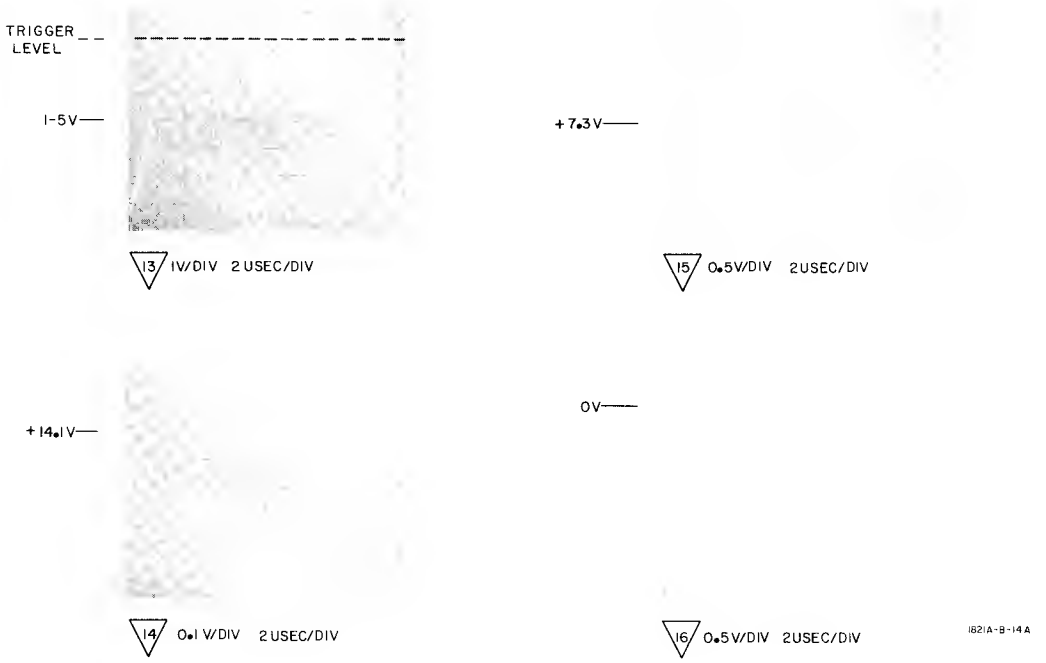
2. All voltages are measured after making control settings.
3. All voltages are referenced to chassis ground.

WAVEFORM MEASUREMENT CONDITIONS

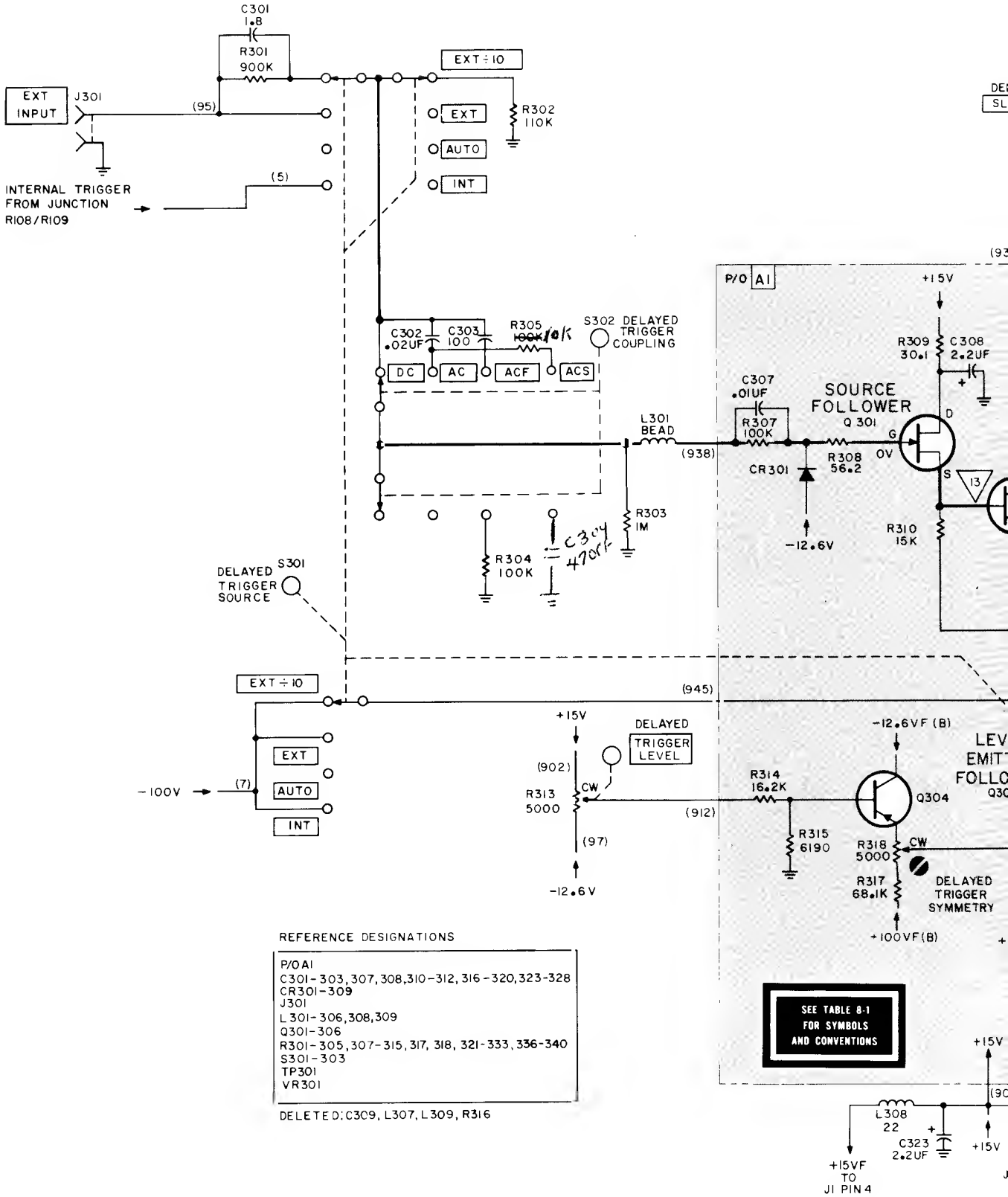
1. Initial Control Settings:

Horizontal DISPLAY	INT
Sweep Display	MAIN
Main TIME/DIV	0.5 µSEC
SWEEP MODE	NORM
DELAY (DIV)	0.50
Main and Delayed VERNIER	CAL
Main and Delayed TRIGGER LEVEL	0
Main and Delayed Trigger Source	EXT
Main and Delayed SLOPE	+ (positive)
Main and Delayed Trigger Coupling	AC

2. Connect a 100 kHz 8 v pk-pk sine wave to Main EXT INPUT and Delayed EXT INPUT.
3. Adjust Delayed TRIGGER LEVEL to obtain waveform number 14.
4. All waveforms are referenced to chassis ground.



Waveforms and Measurment Conditions



REFERENCE DESIGNATIONS

P/O A1
C301-303, 307, 308, 310-312, 316-320, 323-328
CR301-309
J301
L301-306, 308, 309
Q301-306
R301-305, 307-315, 317, 318, 321-333, 336-340
S301-303
TP301
VR301

DELETED: C309, L307, L309, R316

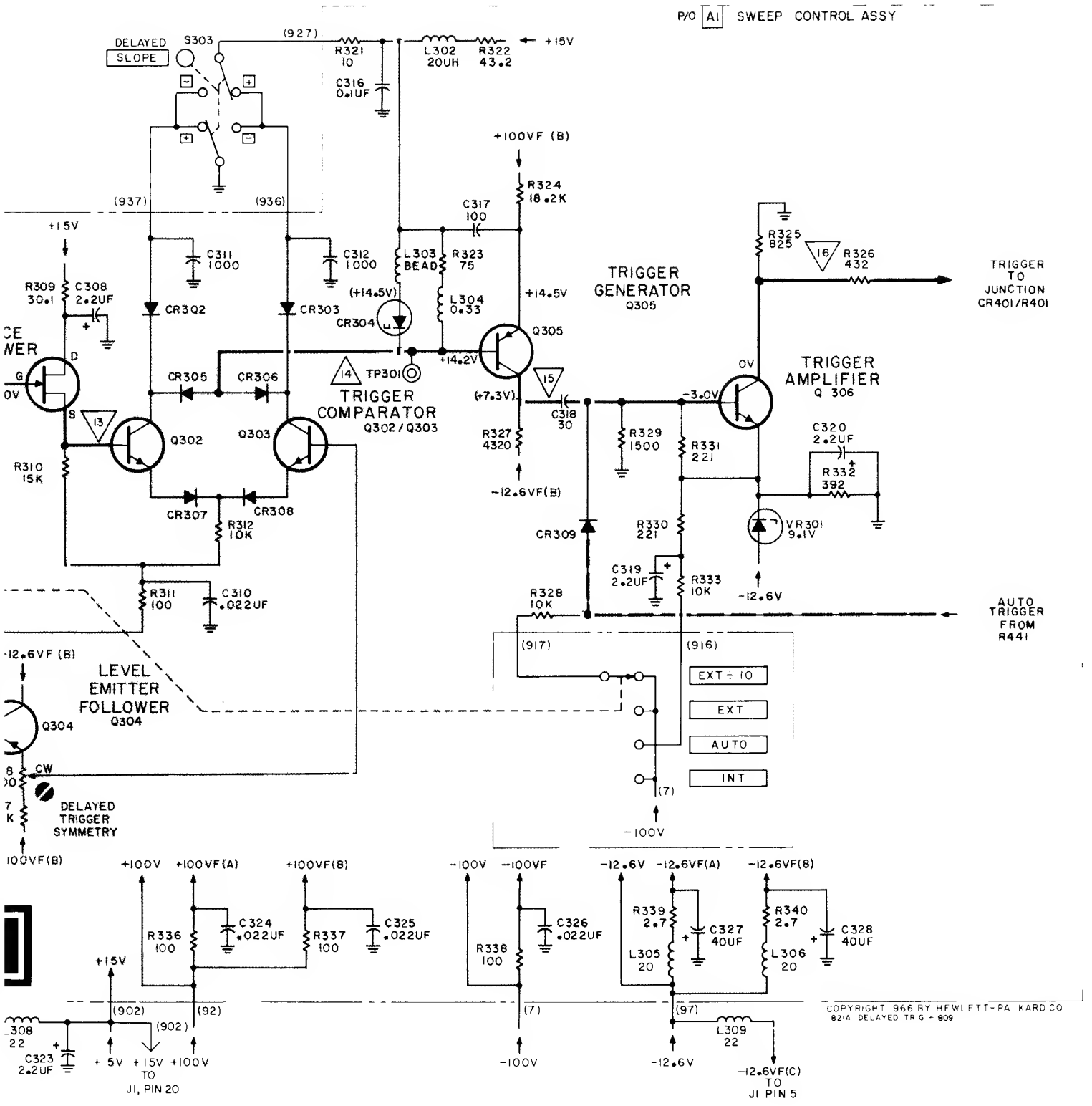


Figure 8-7. Delayed Trigger Schematic Diagram

Component Identification
for A1 in Figure 8-3

Component Identification
for A2 in Figure 8-5

DC VOLTAGE MEASUREMENT CONDITIONS

1. Control Settings:

Horizontal DISPLAY	INT
Sweep Display	MAIN
Delayed TIME/DIV	0.2 µSEC
SWEEP MODE	NORM
DELAY (DIV)	4:00
Delayed VERNIER	CAL
Delayed Trigger Source	EXT÷10

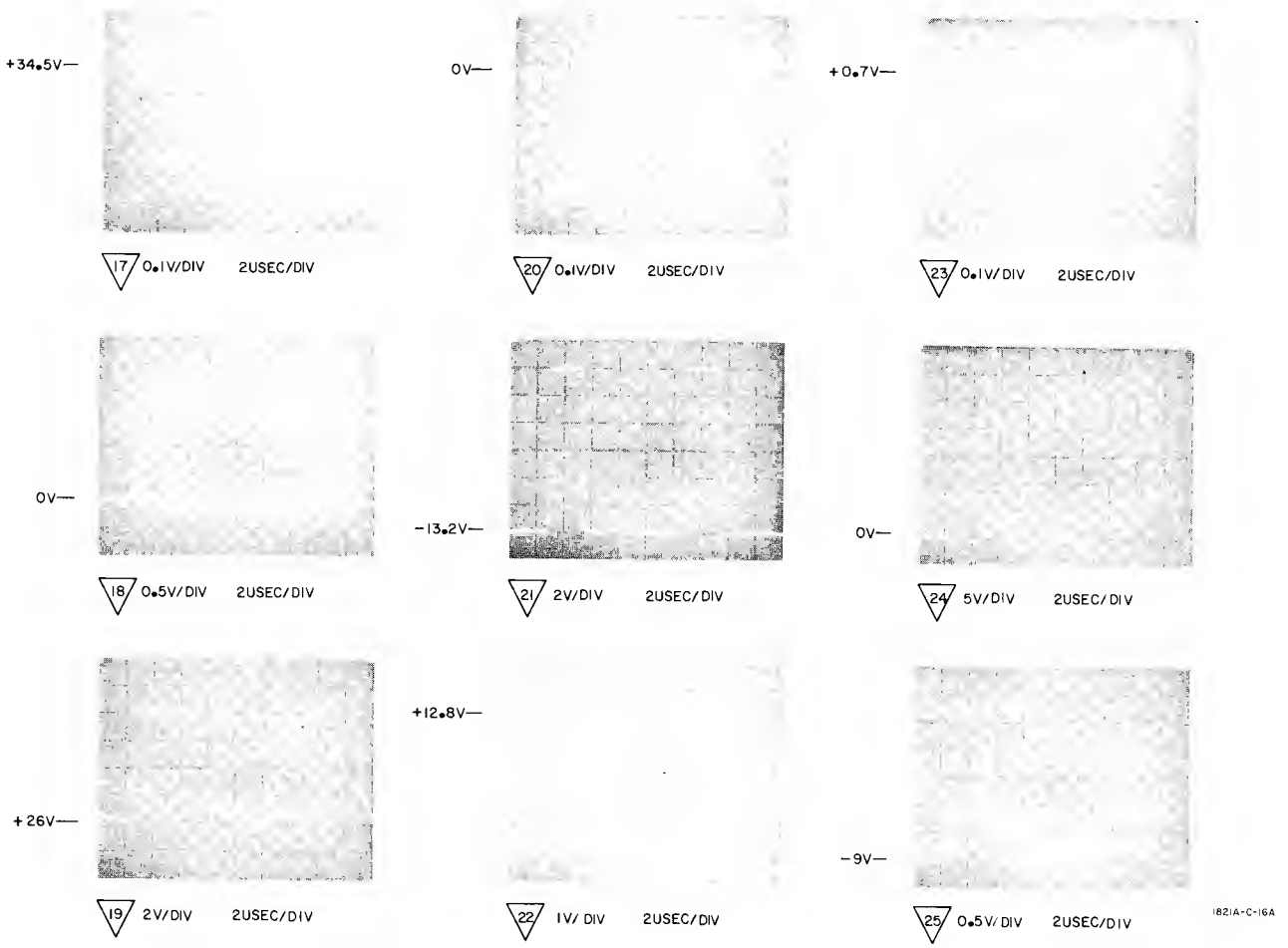
2. All voltages not in parenthesis are measured after making control settings and connecting TP401 through a 1k ohm resistor to -12.6 v.
3. All voltages within parenthesis are measured after making control settings and connecting TP201 through a 1k ohm resistor to -12.6 v.
4. All voltages are referenced to chassis ground.

WAVEFORM MEASUREMENT CONDITIONS

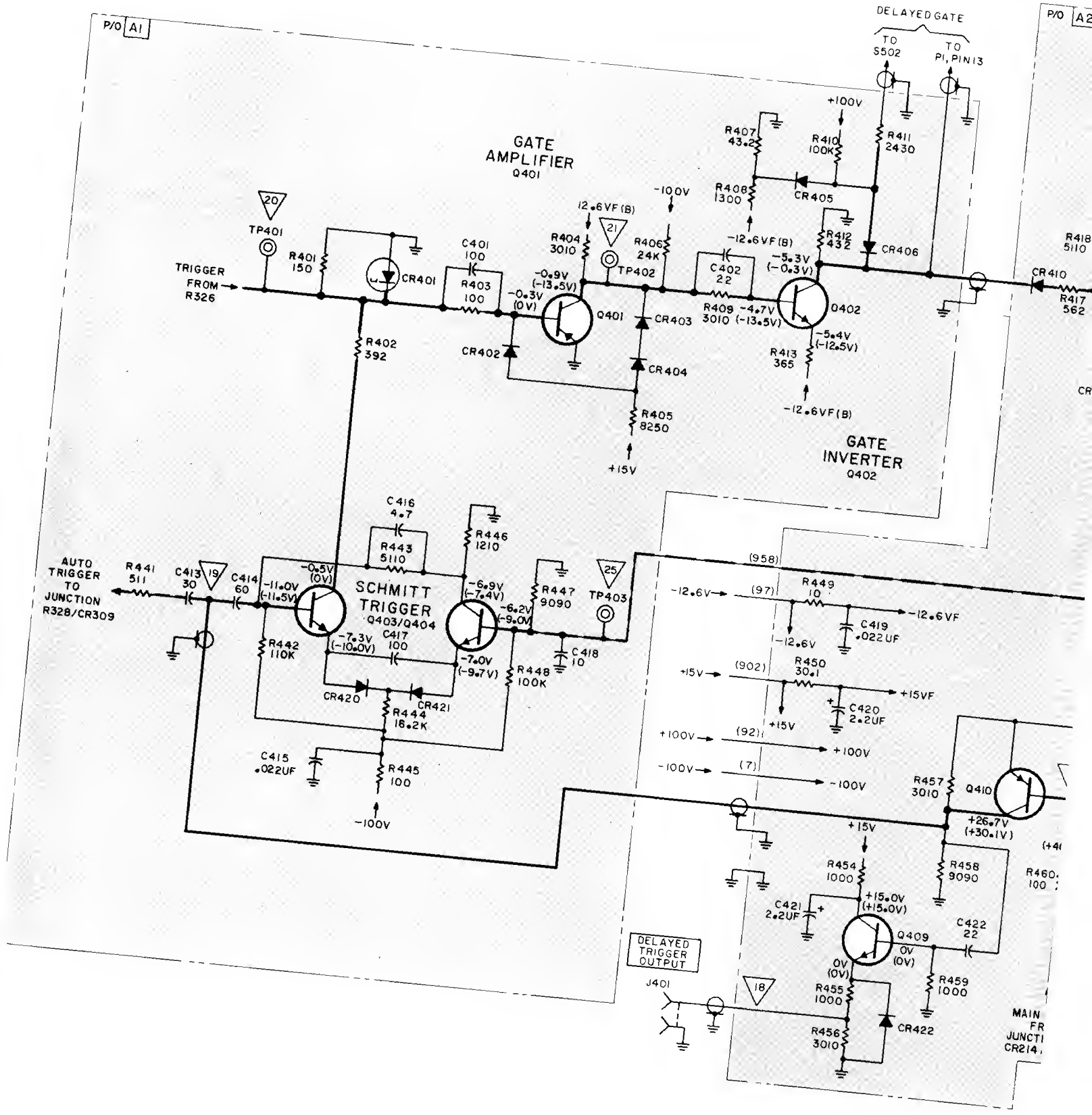
1. Control Settings:

Horizontal DISPLAY	INT
Sweep Display	MAIN
Main TIME/DIV	0.5 µSEC
Delayed TIME/DIV	0.2 µSEC
SWEEP MODE	NORM
DELAY (DIV)	0.50
Main and Delayed VERNIER	CAL
Main and Delayed TRIGGER LEVEL	0
Main and Delayed Trigger Source	EXT
Mainaand Delayed SLOPE	+ (positive)
Main Trigger Coupling	AC
Delayed Trigger Coupling	ACS

2. Connect a 100 kHz 8 v pk-pk sine wave to Main EXT INPUT and Delayed EXT INPUT.
3. Adjust Delayed TRIGGER LEVEL to obtain waveform number 20.
4. All waveforms are referenced to chassis ground.



Waveforms and Measurement Conditions


P/O A1
P/O A2
DELAYED GATE
TO S502
TO P1, PIN 13
GATE AMPLIFIER Q401
GATE INVERTER Q402
SCHMITT TRIGGER Q403/Q404
TRIGGER FROM R326
AUTO TRIGGER TO JUNCTION R328/CR309
DELAYED TRIGGER OUTPUT
J401
MAIN TRIGGER FROM JUNCTION CR214
TP401
TP402
TP403
CR401
CR402
CR403
CR404
CR405
CR406
CR410
CR420
CR421
CR422
Q401
Q402
Q409
Q410
R401 150
R402 392
R403 100
R404 3010
R405 8250
R406 24K
R407 43.2
R408 1300
R409 3010
R410 100K
R411 2430
R412 432
R413 365
R417 562
R418 5110
C401 100
C402 22
C415 .022UF
C416 4.7
C417 100
C418 10
C419 .022UF
C420 2.2UF
C421 2.2UF
C422 22
R441 511
R442 110K
R443 5110
R444 16.2K
R445 100
R446 1210
R447 9090
R448 100K
R449 10
R450 30.1
R454 1000
R455 1000
R456 3010
R457 3010
R458 9090
R459 1000
C413 30
C414 60
+100V
-100V
+15V
-12.6VF(B)
12.6VF(B)
-12.6V
-12.6VF
+15VF
+26.7V (+30.1V)
+15.0V (+15.0V)
-0.9V (-13.5V)
-0.3V (0V)
-4.7V
-5.3V (-0.3V)
-5.4V (-12.5V)
-11.0V (-11.5V)
-0.5V (0V)
-6.9V (-7.4V)
-6.2V (-9.0V)
-7.3V (-10.0V)
-7.0V (-9.7V)
(958)
(97)
(902)
(92)
(7)
0V (0V)

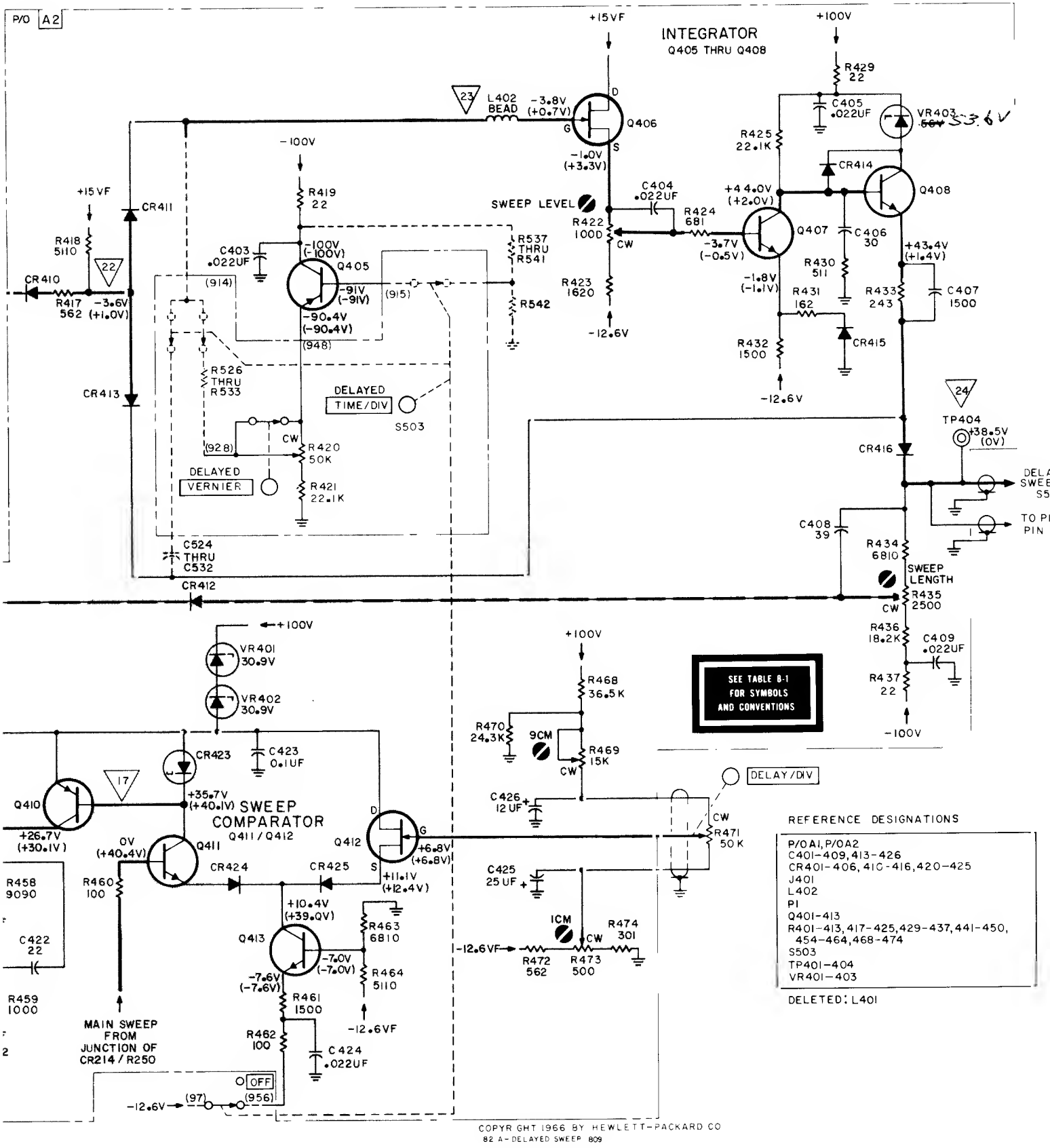


Figure 8-8. Delayed Sweep Schematic Diagram

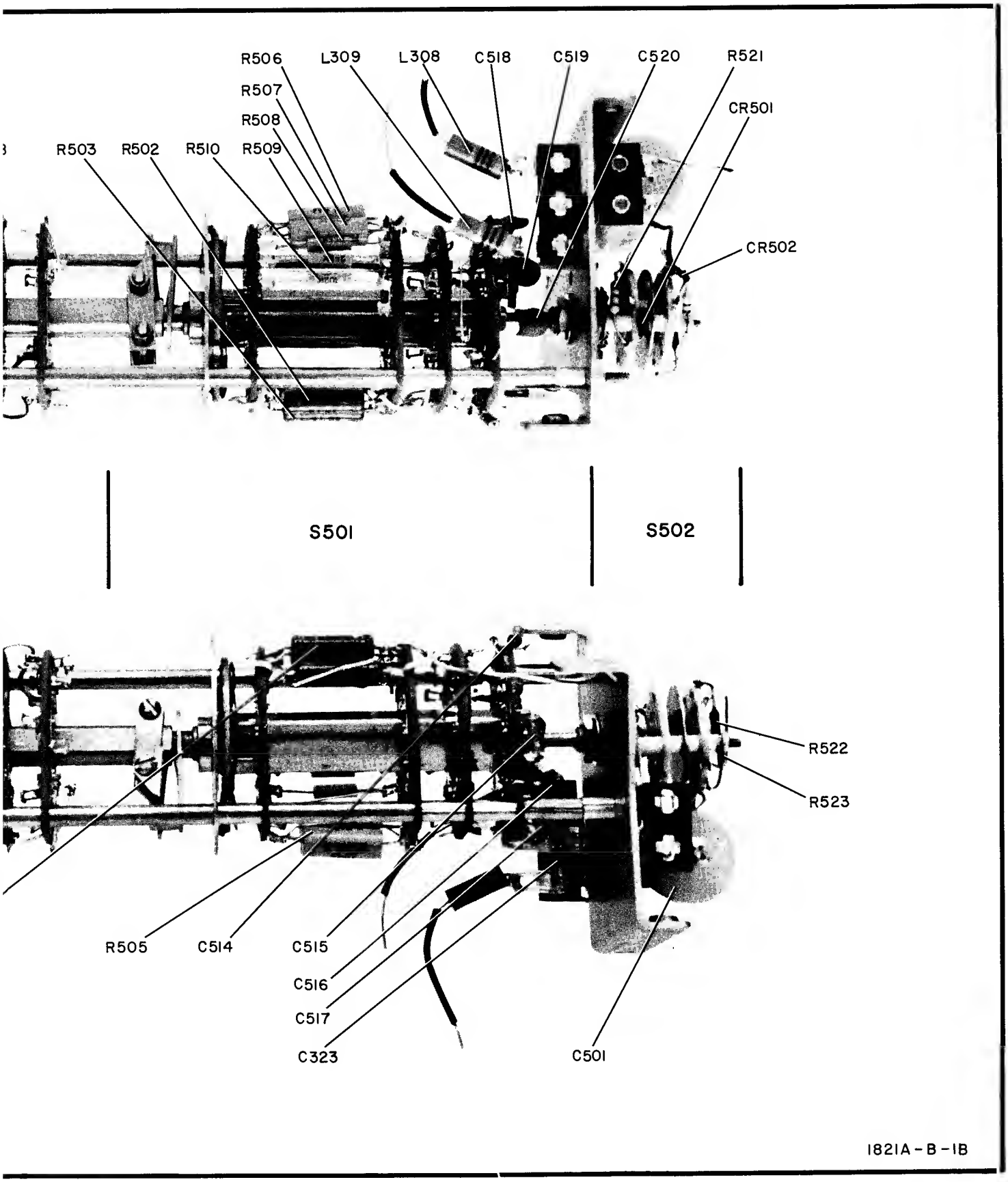


Figure 8-9. Component Identification, Sweep Time Switch (p/o A3)

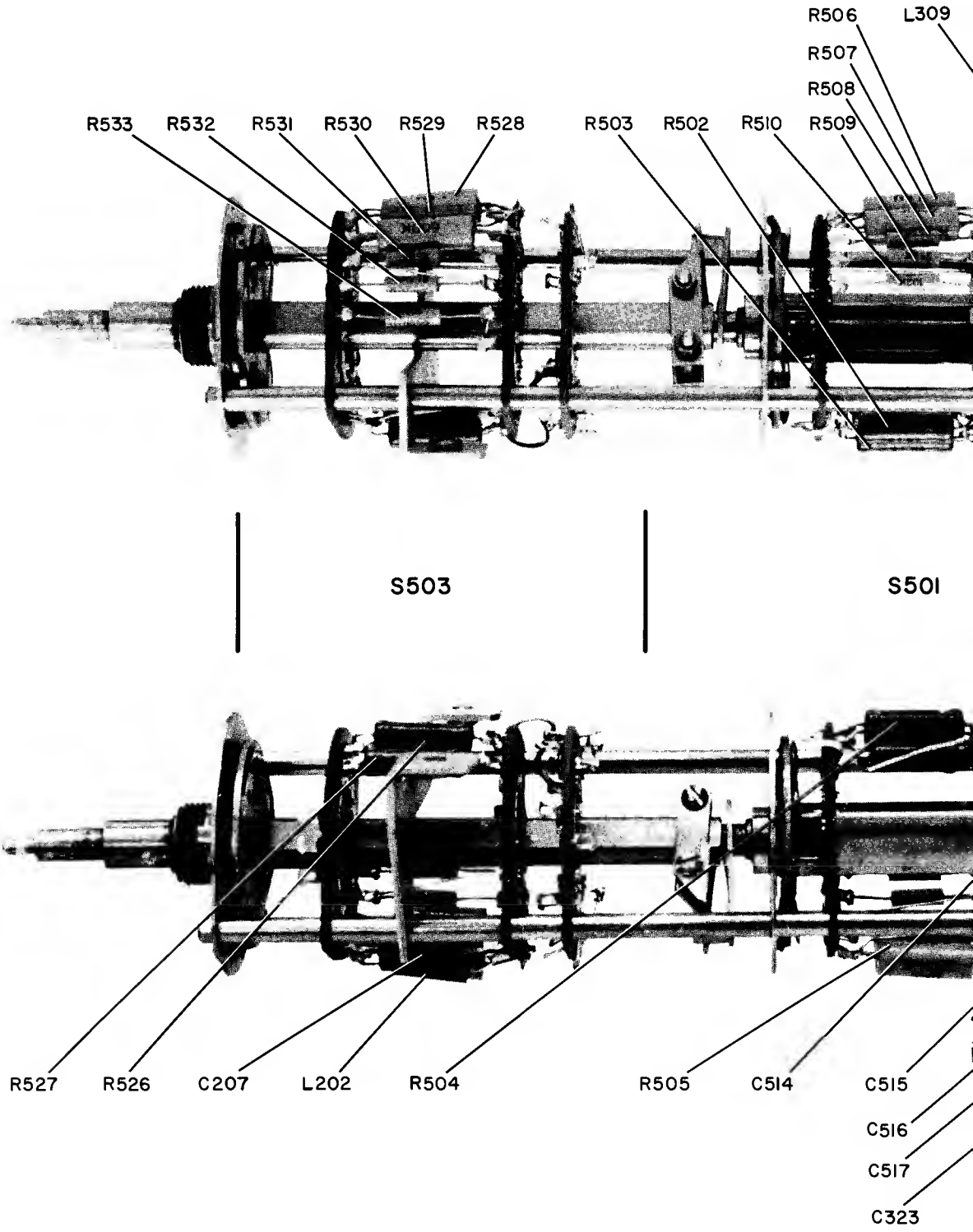
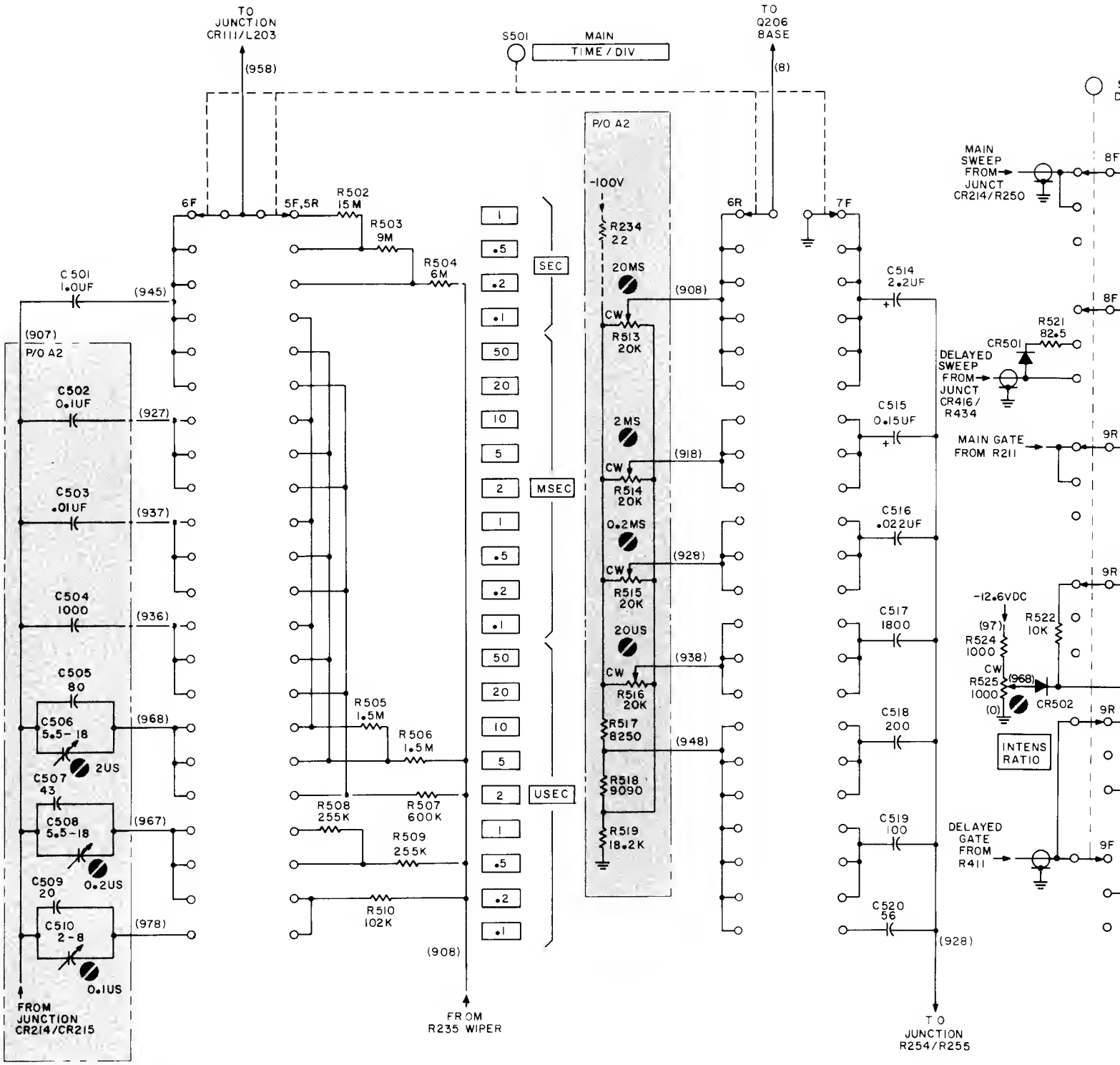

R506
L309
R507
R508
R533
R532
R531
R530
R529
R528
R503
R502
R510
R509
S503
S501
R527
R526
C207
L202
R504
R505
C514
C515
C516
C517
C323

Figure 8-9. Co

Component Identification
for A2 in Figure 8-5


TO JUNCTION CR111/L203
(958)
S501
MAIN TIME/DIV
TO Q206 BASE
(8)
P/O A2
-100V
6F
5F,5R
R502 15M
R503 9M
R504 6M
6R
7F
C501 1.0UF
(945)
(907) P/O A2
C502 0.1UF
(927)
C503 .01UF
(937)
C504 1000
(936)
C505 80
C506 5.5-18
(968)
2US
C507 43
C508 5.5-18
(967)
0.2US
C509 20
C510 2-8
(978)
0.1US
FROM JUNCTION CR214/CR215
R505 1.5M
R506 1.5M
R508 255K
R507 600K
R509 255K
R510 102K
(908)
FROM R235 WIPER
1
.5
.2
.1
50
20
10
5
2
1
.5
.2
.1
50
20
10
5
2
1
.5
.2
.1
SEC
MSEC
USEC
R234 22
20MS
(908)
CW
R513 20K
2MS
(918)
CW
R514 20K
0.2MS
(928)
CW
R515 20K
20US
(938)
CW
R516 20K
R517 8250
(948)
R518 9090
R519 18.2K
C514 2.2UF
C515 0.15UF
C516 .022UF
C517 1800
C518 200
C519 100
C520 56
(928)
TO JUNCTION R254/R255
MAIN SWEEP FROM JUNCT CR214/R250
8F
8F
R521 82.5
CR501
DELAYED SWEEP FROM JUNCT CR416/R434
MAIN GATE FROM R211
9R
9R
-12.6VDC
(97)
R524 1000
R522 10K
CW
R525 1000
(0)
(968)
CR502
9R
INTENS RATIO
DELAYED GATE FROM R411
9F

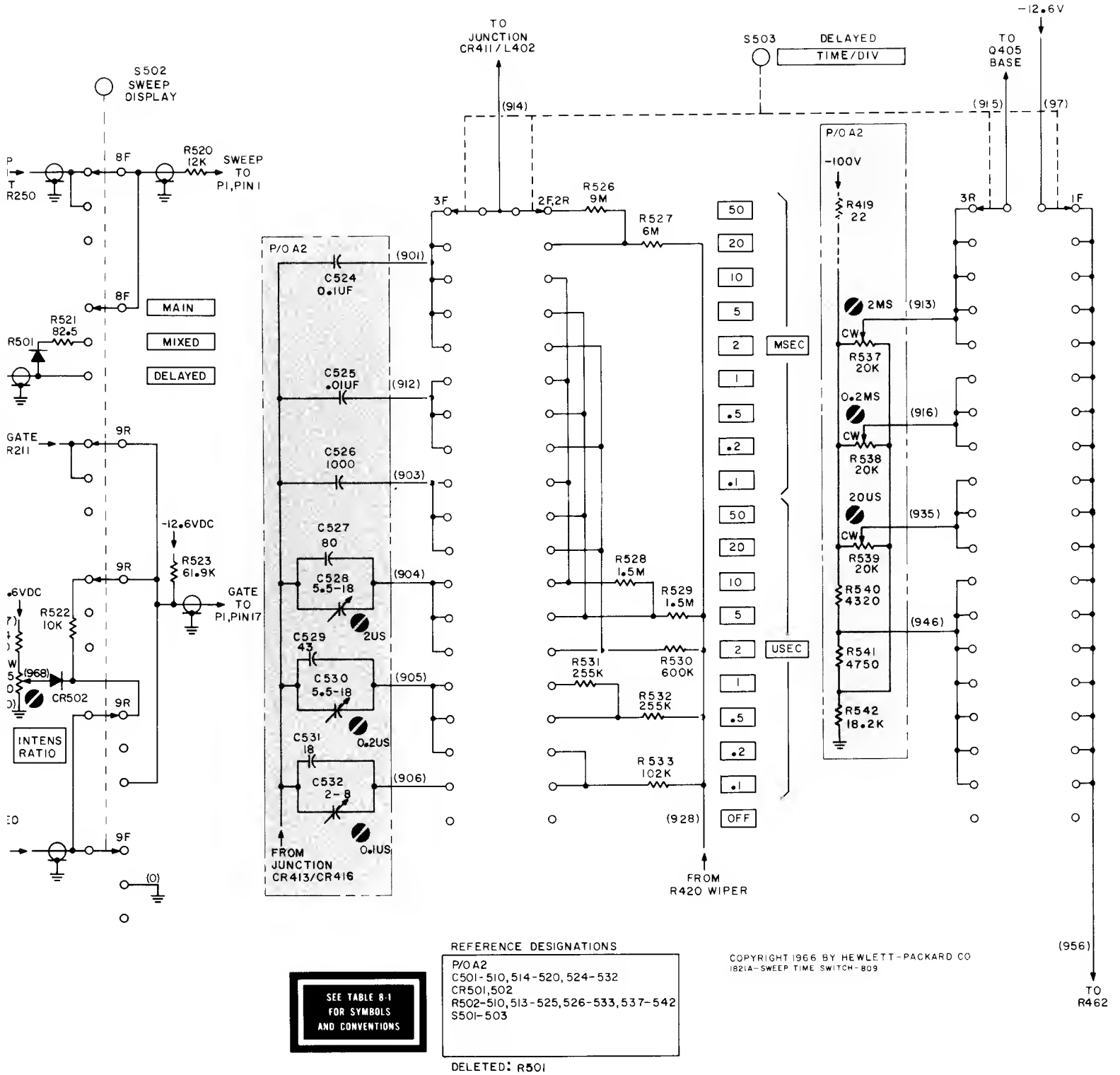


Figure 8-10. Sweep Time Switch Schematic Diagram

01821- 90904

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